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**Article**

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# Inflation and Valuation Practice: German Evidence

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**Abstract** The objective of our paper is to analyze, how valuation practice deals with inflation especially for the terminal value, and how company value is influenced by assumptions set by practitioners. For that reason, we examine how vulnerable companies could be regarding struggles to pass on inflationary effects to their customers. We analyze the inflation rates assumed for the steady-state (terminal value) by comparing them to different estimators for the inflation rate expected at the valuation date (Survey of Professional Forecasters, inflation rates derived by comparing real and nominal rate of returns, inflation swaps). We quantify the implications of using different inflation rates for future cash flow development, terminal value and the company value at the valuation date, and compare nominal reported values with company values in a (hypothetical) world without inflation. Our sample consists of 263 valuation reports written by German auditors with valuation dates between 2000 to 2021. Most of the reports aim at determining the price per share to compensate minority shareholders during a squeeze-out. Our results question inter alia the preference for a constant company specific inflation rate of around 1% on average, and we quantify a number of value effects.

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## 1 Introduction

Inflation rates measured by changes in the consumer price index have recently increased considerably. Proxies for measuring expected inflation have increased as well, albeit to a lesser extent (see Fig. 1). When it comes to DCF (*Discounted Cash Flow*) valuation, expected price changes affect both expected future cash flows and expected rates of return (cost of capital, *Risk-Adjusted Discount Rates* RADR). A company can be valued in real terms or in nominal terms, though mixing real and nominal variables will lead to inconsistent results (see, for example, Moxter 1983, § 24; Ballwieser 1988). Thus, company value does not depend upon the choice between discounting cash flows in nominal terms with nominal RADR and discounting cash flows in real terms with real RADR in general. Despite this equivalence, one can assume that inflation influences company value regularly. This might be due to an inflationary shock, defined as a change in the previously expected inflation rate, which may change cash outflows to a different extent than it changes cash inflows. Inflationary shocks are not relevant for a one-time valuation at a single specific valuation date, for example, to determine the compensation of minority shareholders in case of a squeeze-out, because only the inflation rates expected at this point of time are relevant. This is the setting relevant for our paper, in which we analyze how valuation practitioners deal with inflation. Practitioners usually value companies in nominal terms. Company value in a world with inflation will differ from the company's value in a world without inflation, if inflation affects cash flows and cost of capital differently. This may be caused by the inability of the company to pass on inflation-induced increases of cash outflows to its customers, leading to the use of inflation rates for the cash flow forecast, which are lower than the rates that are part of the nominal RADR. As we will show, this occurs regularly. It implies decreasing nominal cash flows and negative real growth rates. Together with effects caused by the tax regime and historical cost accounting, it also implies that (hypothetical) company values in a world without inflation exceed reported nominal company values.

The objective of our paper is to analyze how valuation practice deals with inflation, especially within the cash flow forecast. In order to specify a manageable and observable scope of 'valuation practice', we focus on valuation reports written by German auditors. Therefore, we analyze 263 reports with valuation dates between 2000 to 2021 in which German listed companies are valued by a DCF valuation, mostly to determine the price per share to compensate minority shareholders during a squeeze-out. Since the reports state the assumed rate of inflation only for the steady-state, and previous studies argue that terminal value makes up about 80% of company value (see Mukhlynina and Nyborg 2020; Schüler and Lagraf 2021), we will focus our value analysis on the terminal value as Schüler and Lampenius (2007)

had done. Based upon the observation that the assumed inflation rates are lower than different proxies for the expected general inflation rate on a regular basis, we analyze the implications of this observation by addressing three research questions. We ask if it could be caused by (I) difficulties of the companies to pass on inflationary effects to customers, or (II) an underestimation of inflation expectations. It is not possible to analyze (I) directly, since this problem is not addressed quantitatively in the reports at all. Therefore, we show the potential effects of an incomplete passing on of inflationary effects on company value, and point out that this problem would also not allow for constant growth rates. We address (II) extensively by inquiring how the cash flow development and company value would change, on average, if the expected inflation rates are used instead of company specific rates, and by calculating the implied real growth rates. Although company specific rates will often differ from expected inflation rates, their average should not be lower for the large sample analyzed here. Thus, we can answer (II) not for individual companies, but for the entire sample. Finally, we ask if (III) reported nominal company values are equal to company values in a (hypothetical) world without inflation. Although company specific inflation rates are lower than the general expected inflation rate on a regular basis, it is not possible to answer question (III) by that observation alone, because there are several effects to be considered for transforming reported nominal company values.

Besides the papers mentioned above, others have analyzed German appraisal reports before. Beumer (2019) collects a number of key valuation assumptions and parameters including the growth rate from 184 reports with a valuation date within the period 2010 to 2018, without a critical assessment or a sensitivity analysis regarding the value impact of these assumptions and parameters. The latter also applies to the paper by Hachmeister et al. (2009), who collect and discuss (amongst other parameters) the growth rate used in 122 appraisal reports with valuation dates between 2002 to 2008. Schüler and Lagraf (2021) analyze a sample similar to ours, but do not focus upon the assumed inflation rate and do not conduct a value analysis. Different from Schwetzler (2022a), who discusses the implications of the method to deal with the retention of earnings justified by inflation for 158 appraisal reports from 2011 to 2020 *given* the assumed inflation rates, we focus on the level of the assumed inflation rates *given* the method. Our analysis of question (III) will show that the value effects in Schwetzler (2022a) are a subset of the effects covered here.

Thus, our paper contributes to the existing literature by analyzing a larger and more recent sample, but mostly because we quantify the implications of the assumptions regarding the expected inflation. To achieve this objective, we first use some of the indicators introduced by Schüler and Lampenius (2007) for analyzing the implied future cash flow development. Beyond that, the second and third part of our analysis is devoted to value effects.

We work with the overall valuation framework used by the auditors as shown in Becker et al. (2018, Chapter A), and Tschöpel et al. (2010a, b), and focus on as-if-valuations by using different estimators for the future inflation rate(s) expected at the valuation date. We analyze inflation only, and do not contribute to the literature that discusses the challenges imposed by combining and handling different drivers

for growth (see, for example, Bradley and Jarrell 2008; Friedl and Schwetzler 2010; 2011; Schwetzler 2022a).

The paper is structured as follows: Sect. 2 will provide a brief description of our sample. In Sect. 3 we summarize the key features of the valuation approach of German auditors, set the assumptions, and discuss the estimation of future inflation rates expected at the valuation date. We employ three different estimators for expected inflation (survey results, rates implied by returns on German governmental bonds, inflation swaps). Additionally, we describe the methodology used in order to answer our research questions (I) through (III). We introduce our approach to measure the implied development of cash flows, the gap between reported terminal values and terminal values based upon expected general inflation rates, and between reported terminal values and terminal values in a (hypothetical) world without inflation. Section 4 presents and discusses the results of our empirical analysis. Section 5 contains our conclusions.

## 2 Sample

Our sample contains 263 reports ranging from 2000 until 2021, that value listed German companies as required by German law, for example because of a squeeze-out of minority shareholders. All these reports valued the respective company with a DCF valuation. We reconstructed the DCF valuation case by case in order to conduct as-if-valuations for our empirical analysis. Most of the valuations (71%) occurred due to a squeeze-out (German Stock Corporation Act: § 327a ff. AktG). The sample also includes valuations due to profit transfer agreements that require a compensation of shareholders of the dominated company (20%), and valuations due to a merger for determining the distribution of ownership after the merger (9%). The sample covers various industries, with many valuations of companies belonging to the sectors *Industrial Goods and Services* and *Technology*. Table 1 shows the valuations by industry (Panel A) and by valuation date (Panel B).

## 3 Method

### 3.1 Overview of the Valuation Framework Used in the Sample

The *Flow to Equity* method is used for the DCF valuation in all reports analyzed: the levered *Free Cash Flows* or *Flows to Equity* (FtE) are discounted by the levered cost of equity to the value of equity. The cash flow forecast consists of a detailed forecast, on average, for the next 5 years followed by a perpetuity setting (steady-state) covering all years beyond the detailed forecast, except for about 10% of the cases where the detailed forecast is followed by a convergence period. For both alternatives, the present value of the cash flows beyond the end of the detailed forecast or the end of the convergence period is calculated as the present value of a growing perpetuity (terminal value).

With the exception of a few older cases, the *Capital Asset Pricing Model* (CAPM) is applied to derive the RADR. For most valuations, the risk-free rate is determined according to the procedure suggested by the *Institute of auditors in Germany (Institut der Wirtschaftsprüfer in Deutschland, IDW)* that refers to the yield curve to obtain a single risk-free rate by averaging and rounding as shown in Becker et al. (2018, pp. 138–139). This procedure has been subject to criticism (see, for example, Bassemir et al. 2012; Drukarczyk and Schüler 2021, pp. 254–255), but will not be replaced by a more precise method in our paper. The market risk premium is regularly chosen from the bandwidth recommended by the IDW at the valuation date, and will also not be addressed. The transition from the unlevered cost of equity to the levered cost of equity depends upon the transition from the unlevered beta value to the levered beta value. Exemptions are the valuation of unlevered companies and a few older valuations that do not employ the CAPM. This beta transformation is not shown in detail in the reports. When we reconstructed the valuations manually, we saw that the predominant way to link unlevered and levered beta values was to follow Harris and Pringle (1985) in recent years in that they link unlevered and levered cost of equity, since Harris and Pringle do not apply the CAPM.

The information about both expected interest payments and expected levels of debt employed, as well as the link between unlevered and levered cost of equity

**Table 1** Valuation reports by industry according to the Industry Classification Benchmark (ICB) supersectors, and by valuation date

Panel A: Sample by industry		Panel B: Sample by valuation date	
Industrial Goods and Services	49	2000	3
Technology	47	2002	30
Real Estate	23	2003	20
Health Care	18	2004	4
Consumer Products and Services	14	2005	12
Media	13	2006	6
Financial Services	13	2007	9
Energy	12	2008	12
Automobiles and Parts	12	2009	14
Chemicals	12	2010	12
Construction and Materials	12	2011	13
Telecommunications	10	2012	21
Food, Beverage and Tobacco	9	2013	18
Others	8	2014	19
Basic Resources	5	2015	13
Retail	4	2016	10
Travel and Leisure	2	2017	16
		2018	6
		2019	10
		2020	10
		2021	5
Σ	263	Σ	263

is incomplete. This prevents us from modeling the impact of a change in terminal value of equity on the levered cost of equity of preceding years. When the modified terminal value of equity exceeds the reported terminal value of equity, the leverage ratio (debt/equity) would decrease, leading to lower levered cost of equity and a higher value of equity at the valuation date. In order to avoid mixed results, we refrain from correcting only the cases for which we can adjust the discount rates and not correcting all other cases.

Since we are interested in the inflation rate used in the valuations by German auditors, we will focus on the terminal value, i.e., the present value of all future expected cash flows after the cash flow forecast has ended, as there is no information about the inflation rates used by the valuers for the years within the detailed forecast horizon or the convergence period. For the growing perpetuity representing all years after the end of the detailed cash flow forecast or the end of the convergence period, the valuers have to determine a growth rate. Growth is driven either by capital expenditures—ignoring an impossible infinite growth due to cost decreases (real growth)—or price increases (inflation). The Fisher-equation is usually applied to rates of return free of the risk of default (i).<sup>1</sup> Applying it to growth rates, skipping the expectation operator for the sake of a simpler presentation, and assuming a covariance between real growth and inflation of zero the relationship between expected real growth ( $g_R$ ), expected inflation ( $\pi$ ) and expected nominal growth ( $g_N$ ) is as follows:

$$g_N = (1 + g_R)(1 + \pi) - 1 \tag{1}$$

It can also be used for linking nominal (index N) and real (index R) RADR ( $r$ ) with the expected inflation, assuming a covariance between  $r$  and  $\pi$  of zero:

$$r_N = (1 + r_R)(1 + \pi) - 1 \tag{2}$$

Purchasing power equivalence can be illustrated for the terminal value (of equity), TV, with  $E_R$  denoting the value of equity in real terms and  $E_N$  the value of equity in nominal terms for a simplified cash flow-based model and by ignoring any other challenges caused, for example, by the tax regime:

$$TV = \frac{\overbrace{FtE_R}^{FtE_N}}{\underbrace{r_{LR} - g_R}_{E_R}} = \frac{\overbrace{FtE_R(1 + \pi)}^{FtE_N}}{\underbrace{(1 + r_{LR})(1 + \pi) - 1}_{r_{LN}} - \underbrace{[(1 + g_R)(1 + \pi) - 1]}_{g_N}} \tag{3}$$

Since the year 2005, German auditors do not use a economy-wide nominal growth rate for filling out Eq. 3, but include the expansion-induced increase of retained earnings in the numerator in an equivalent manner for the vast majority of the cases, by assuming that the NPV on this additional investment is zero (see Becker et al.

<sup>1</sup> For the Fisher equation see Fisher (1907, p. 359), and Chapters II and XIX in Fisher (1930).

2018, pp. 170–178). As a consequence, FtE does not only consist of dividends paid, but also of this portion of the earnings retention assuming this increase in retained earnings equals its value contribution. The growth rate left in the denominator must be predominantly induced by inflation. However, whether any of this (remaining) growth is caused by real growth can remain unclear, because the reports can be quite unspecific in this regard. We refrain from speculating about this problem, which cannot be solved quantitatively with the available data, and assume below that the remaining growth rate is inflation-induced. Nevertheless, we solve Eq. 1 for the implied real growth with using the general expected inflation rate, if the company specific growth rate were a nominal growth rate. This rate is company specific as there is no single rate that captures all the expected changes in prices for input and output factors for each company. We use the variable  $\pi_C$  for the company specific inflation rate in the following. Since 2010, a number of reports show an additional increase in retained earnings to the amount of  $\pi_C$  times book value of equity ( $E_{BV}$ ), and since 2011 a tax payment on the inflation-induced increase in terminal value. The latter is defined by  $\pi_C$  times half of the personal income tax (in German: *Abgeltungsteuer*) times the terminal value. Although the reports can be quite vague in motivating the former effect, we treat it as being inflation-induced in our analysis, because its definition ( $\pi_C E_{BV}$ ) is based on this interpretation.

### 3.2 Assumptions

We set the following assumptions:

- We already assumed the Fisher-equation to hold in Eq. 2. This implies that state-contingent expected real rates of return (cost of capital) are independent from state-contingent inflation rates. Therefore, the covariance between real cost of capital and inflation rates is assumed to be zero. Eq. 2 also implies that the risk premia can be transformed accordingly.
- The covariance between state-contingent real cash flows and state-contingent inflation rates is also assumed to be zero.
- The risk-free rate and the market risk premium employed by the auditors for deriving the cost of capital with the CAPM are not analyzed any further, and will remain unchanged.
- The derivation of the unlevered beta value (asset beta) and its transformation into the levered beta value (equity beta) is not analyzed or modified.
- Besides the modifications necessary due to the methodological approach chosen, we do not change the cash flow forecast. We accept the assumptions used in the reports concerning taxation, capital structure, and dividend policy.
- We also do not analyze whether the assumption of the valuers that expansion-induced growth in the steady state is NPV-neutral is modelled in a correct manner. Thus, we only analyze the company specific growth rate that we assume to be inflation-induced. If this growth rate would also include a real growth component, the gap between the company specific inflation rate and the general expected inflation rate would be even wider leading to larger as-if-value effects. We will illustrate that by solving (1) for the implied real growth rate.



- We focus upon the terminal value at the end of the detailed forecast horizon or the end of the convergence period, because the expected company specific inflation rate is shown explicitly by the valuers in the usual formula to value a growing perpetuity.
- We assume the valuation at the valuation date is based upon the expectations at this valuation date. This is a common assumption that implies that we cannot incorporate any effects of an unexpected change in inflation or expected inflation (inflation shock) in future years.
- As mentioned above, for valuation dates prior to 2005 (57 out of 263 cases), the expected expansion-induced growth was not part of the cash flow but included in the company specific growth rate. Since there is hardly any information in these reports about which company specific inflation rate is implied, and the mean and median of the rates both are at the same level as company specific inflation rates in more recent reports, at about 1% (see also Schüler and Lagraf 2021, p. 141), we do not separate these older cases from the majority of the cases that report a company specific inflation rate.

### 3.3 Estimation of Expected Inflation Rates

The nominal FtE, the nominal RADR, and  $\pi_C$  are given in the reports. The RADR, in nominal terms, contains the economy-wide rate of inflation expected by the market ( $\pi$ ). A consumer price index is used as the general inflation rate on a regular basis. This is justified since the expected nominal return to investors (RADR) defines their consumption potential in nominal terms. We need to estimate expected inflation rates at the valuation date for two reasons. First, they can serve as a point of reference for the company specific rates. Second, we will need them to transform the RADR in nominal terms into the RADR in real terms.

In contrast to realized price changes, inflation expectations are not directly observable and have to be extracted from surveys or prices of inflation-linked securities or derivatives (Deutsche Bundesbank 2015). While surveys offer the opportunity to learn about the inflation expectations of market participants, inflation expectations drawn from security prices can be affected by risk premia (Deutsche Bundesbank 2014, p. 75; 2015, pp. 46–47). However, due to the underlying market transactions, financial products offer an inflation estimate free of strategic under- or overestimation. Based upon the existing literature on the topic, as for example European Central Bank (2021), Koester et al. (2021), Speck (2016) or Schüler and Lampenius (2007), we use several estimators of expected inflation:

1. *Survey of Professional Forecasters (SPF)*: The SPF is a quarterly survey of the *European Central Bank* (ECB) among professional forecasters from the financial sector and research institutions located in the European Union. It provides an established data set for (long-term) inflation expectations in the Eurozone (Möhrle 2020). We use the average long-term (five years ahead) Euro area annual *Har-*

*monised Index of Consumer Prices* (HICP) inflation point estimate.<sup>2</sup> The series is available beginning with the third quarter of 2002. Since the data is only available on a quarterly basis, we use the expected rate of a quarter for all valuation dates falling within this quarter.

2. *Implied inflation rates*: Expected rates of inflation can be inferred from linking expected real interest rates and nominal interest rates on German government bonds by solving Eq. 2 for the expected inflation rate. We use the monthly data for expected real interest rates of German government bonds with a remaining maturity of ten years published by the Deutsche Bundesbank.<sup>3</sup> The series is available for all years within our sample period. Since the data is only available on a monthly basis, we use the expected rate of a month for all valuation dates within this month. It should be noted that the Deutsche Bundesbank itself uses survey data on the expected inflation rates according to the forecasts sold by Consensus Economics Incorporated (Deutsche Bundesbank 2022) for calculating the real interest rates. This data set is not available to us. Thus, we essentially estimate these survey-based expectations in a retrograde manner. Other than the Eurozone-based SPF, which serves to forecast the inflation in the Eurozone, the comparison of nominal with real interest rates on German governmental bonds serves to estimate the German inflation rates. One could argue that the latter is in line with the domicile principle set forth in IDW standards. Since one could also argue that the Eurozone is a larger market served by many of the companies analyzed, our use of both indicators covers both arguments.
3. *Inflation swaps*: Inflation buyers and inflation sellers exchange fixed and variable rates on the same notional amount. The floating rate is determined by the inflation development during the contractual period. The annualized fixed rate (swap rate) can be interpreted as the daily available estimator for the expected inflation for a given future date (Deutsche Bundesbank 2015). Additionally, swap rates for different horizons enable us to calculate implied forward inflation rates. A prominent swap rate, used, for example, in Deutsche Bundesbank (2014, 2015) and Speck (2016), is the 5Y5Y forward inflation rate. It is the annualized inflation rate over a five-year period beginning in 5 years' time. The rate can be derived from inflation-linked swap rates (ILS) of contracts with a maturity of 5 and 10 years. Generally, forward rates between year  $m$  (with  $m > 0$ ) and year  $n$  (with  $n > m$ ) can be calculated using the inflation-linked swap rates as follows:

$$\begin{aligned}
 (1 + \pi_{0 \rightarrow n})^n &= (1 + \pi_{0 \rightarrow m})^m (1 + \pi_{m \rightarrow n})^{n-m} \\
 (1 + \pi_{m \rightarrow n})^{n-m} &= \frac{(1 + \pi_{0 \rightarrow n})^n}{(1 + \pi_{0 \rightarrow m})^m} \\
 \pi_{m \rightarrow n} &= \left[ \frac{(1 + \pi_{0 \rightarrow n})^n}{(1 + \pi_{0 \rightarrow m})^m} \right]^{1/n-m} - 1
 \end{aligned} \tag{4}$$

<sup>2</sup> The data is available at: [https://sdw.ecb.europa.eu/quickview.do?SERIES\\_KEY=138.SPF.Q.U2.HICP.POINT.LT.Q.AVG](https://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=138.SPF.Q.U2.HICP.POINT.LT.Q.AVG).

<sup>3</sup> We use the time series BBK01.WZ8587 (real interest rates) and BBSIS.M.I.ZAR.ZI.EUR.S1311.B.A604.R10XX.R.A.A.\_Z.\_Z.A (in our opinion an appropriate nominal equivalent).

It should be noted that the calculation used in Speck (2016, p. 6) is based upon logarithmic rates. This is also true for the 5Y5Y rate provided by Bloomberg.<sup>4</sup> It can be shown that Eqs. 4 and 1 in Speck (2016) are equivalent. One should remember to re-transform logarithmic rates, like the 5Y5Y rate, into their discrete equivalent, because the usual valuation framework is based upon discrete planning and discounting. Otherwise, a valuation error will occur.

Bloomberg offers quotes on inflation swaps for 1 through 10 years, as well as for 12, 15, 18, 20, 25, 30, 35, 40, 45 and 50 years. Since we focus on inflation effects in the terminal value, we calculate the forward inflation rate starting at the end of the detailed forecast horizon or the end of the convergence period for each valuation until year 30. With reference to Eq. 4, we set  $m$  equal to the last year of the respective forecast horizon; this is in line with our assumption to refrain from analyzing inflationary effects prior to the steady-state. Then, we have to decide how to use the data available for all periods after  $m$ . Since the risk-free rate used in most of the reports is derived from the German yield curve, which covers maturities up to 30 years, we pragmatically use the swap rate for year 30 ( $n = 30$ ). Finally, we apply Eq. 4 and calculate the annualized forward rate that is assumed to be constant for all periods after period  $m$ . For a detailed forecast for the next 5 years, for example, we apply the rate 5Y25Y. We acknowledge that other approaches might be possible. We do not analyze the matter any further here. Since the data needed is available beginning in June 2004 on a daily basis, we can apply the specific rates for each valuation date after this date only.

There is also the possibility to derive inflation expectations from the difference of the yields of (equivalent) nominal and inflation-linked government bonds (Deutsche Bundesbank 2015). We refrain from using this so-called *Break-Even Inflation Rate* (BEIR) because the number of inflation-linked government bonds is limited; currently, only 5 German inflation-linked bonds have been issued, and data is available only from 2009 onward.

We refrain from picking one of the three estimators presented here, and instead report most results for all of them and test the differences in the results regarding their statistical significance. Nevertheless, we think the inflation-linked swaps provide considerable potential: they cover a set of different periods that also allow for the calculation of forward swap rates. Therefore, they are not only quarterly point-forecasts like the SPF rates, and are not solely survey-based like, again, the SPF rates and also the implied inflation rates, but derived from market transactions.

### 3.4 Research Approach

We use the following measures to answer our research questions I through III:

**I. Incomplete Passing on of Increasing Input Prices:** Based upon Eq. 1, we analyze the distinction between growth of cash inflows and the growth of cash outflows including the company's ability to pass over increases of prices for input

<sup>4</sup> These rates can be accessed in Bloomberg via the following tickers, e.g. FWISEU55 (5Y5Y forward inflation rate) or EUSWIT30 (30-year zero coupon inflation swap).

factors to its customers. Schüler and Lampenius (2007) came up with definitions of critical time periods in that regard. These critical time periods, or critical numbers of years, show the consequences if a company is not able to pass on increasing prices of input factors to its customers. We measure the ability of a company to pass on inflation by the variable  $d$ . As German auditors mostly include the value contribution of expansion-induced growth in the numerator of the value equation beginning in 2005, unlike Schüler and Lampenius (2007) we can focus on the company specific inflation rate here. Hence, we adjust their approach slightly.

Critical period  $t'$ : This is the point in time in which the nominal cash flow starts to decrease, if the company is not able to pass on inflation completely, i.e.,  $d < 1$  (see Appendix). We use the variable  $g_c$  to measure the combined rate of growth that depends upon the level of  $d$ :

$$g_{c,t} = \left[ (1 + d\pi_C) \frac{CI_{t-1}}{FtE_{t-1}} - (1 + \pi_C) \frac{CO_{t-1}}{FtE_{t-1}} \right]^{-1} \quad (5)$$

$$t' = 1 + \ln \frac{d\pi_C CI_0}{\pi_C CO_0} \cdot \left( \ln \frac{1+\pi_C}{1+d\pi_C} \right)^{-1} \quad \forall t' \geq 1 \quad (6)$$

$$t' = 1 + [\ln(dCI_0) - \ln(CO_0)] \cdot \left( \ln \frac{1+\pi_C}{1+d\pi_C} \right)^{-1}$$

CI stands for cash inflow, and CO for cash outflow. For our empirical analysis, we use revenues for CI and the difference between revenues and EBIT for CO, each for the first year of the steady-state, in order to get results that are not influenced by corporate taxes, interest earned on liquid funds or cash flow effects of debt financing. Besides, we need to use this simplified cash flow measure, because the change in net working capital is not shown in the reports. It should be noted that in the case of an incomplete passing on of inflationary effects, the company specific growth rate cannot be constant over time.

Critical period  $t''$ : Point in time in which the nominal cash flow turns negative, if a company is not able to pass on inflation completely ( $d < 1$ ):

$$t'' = \frac{\ln \frac{CI_0}{CO_0}}{\ln \frac{1+\pi_C}{1+d\pi_C}} \quad \forall t'' \geq 1 \quad (7)$$

Equation 7 follows from Eq. 5 by setting equal the CI-term and the CO-term on the RHS, both compounded over  $t''$  years.

There are cases in which both  $t'$  and  $t''$  are negative, because the EBIT margin is very small. Thus, it is possible that even for  $d$  only slightly below 1 the change in EBIT is negative for the first forecast year. In our empirical analysis, we set  $t'$  and  $t''$  equal to 1 in these instances. Since the valuation reports do not apply different inflation rates to CI and CO, nor to components of CI and CO, we use one single company specific inflation rate for each case during our analysis.

The critical periods  $t'$  and  $t''$  illustrate the potential vulnerability of a company to difficulties in passing on increasing input prices. It is important for a valuator to check the assumption set to value the company accordingly.

**II. Cash Flow Development, Implied Real Growth Rates and Value Effects for Company Specific Inflation Rates Below Expected Inflation Rates:** Critical period  $t^*$ : This is the point in time in which FtE written forward with the company specific inflation rate is  $x\%$  of the beginning FtE written forward by the general inflation rate, if  $\pi_C \neq \pi$ :

$$x_t = \frac{FtE_0(1 + \pi_C)^t}{FtE_0(1 + \pi)^t} \tag{8}$$

$$\ln x = t * [\ln(1 + \pi_C) - \ln(1 + \pi)] \tag{9}$$

$$t^* = \frac{\ln x}{\ln(1 + \pi_C) - \ln(1 + \pi)}$$

Implied real growth rate ( $g_R$ ): As introduced above, we solve Eq. 1 for the implied real growth rate, if the company specific rate were a nominal growth rate. For doing so, we use the estimated general growth rate:

$$g_R = \frac{1 + \pi_C}{1 + \pi} - 1$$

Additionally, in order to show the value effect of using a company specific inflation rate that differs from the general expected inflation rate, we also substitute the latter for the former for calculating a revised terminal value ( $TV^*$ ), and calculate the difference to the reported terminal value ( $\Delta TV = TV^* - TV_{reported}$ ). In order to show the impact at the valuation date, we show the difference between the reported value of equity ( $E_{reported}$ ) and the modified value of equity ( $E^*$ ) at the valuation date ( $\Delta E$ ). It could be assumed that the FtE at the beginning of the perpetuity is inflated by  $(1 + \pi_C)$  from the last period of the detailed forecast horizon or the convergence period, although this is not addressed in the reports directly. Therefore, we use two variants: for the first one, we do not adjust FtE ( $\Delta TV_a$  and  $\Delta E_a$ ) regarding to this effect; for the second one, we inflate FtE by the general expected inflation rate and deflate it by the company specific rate ( $\Delta TV_b$  and  $\Delta E_b$ ):  $(1 + \pi) / (1 + \pi_C)$ . This is a simplification as our analysis to answer question (III) will show. We will report our results in % of  $TV_{reported}$  and  $E_{reported}$ . In line with our assumption mentioned above, we do not try to adjust the levered beta value and the levered cost of equity for discounting the terminal value to the valuation date. This is another simplification, because the ratio of debt to equity will change, if debt remains constant, and the value of equity will change with it.

**III. Deviation from the Company Value in a World Without Inflation:** We compare the reported (nominal) terminal value ( $TV_{reported}$ ) with the terminal value in a (hypothetical) world without inflation ( $TV_R$ ). Besides determining the real RADR, the cash flow in real terms has to be derived in order to estimate the terminal value in real terms. Due to a lack of data and a non-transparent transition from the cash flow reported for the end of the detailed forecast horizon to the cash flow reported for the beginning of the steady state, we need to set some pragmatic assumptions.

The transition follows 5 steps: We omit the company specific inflation rate (1), solve Eq. 2 for the real cost of capital (2), add back the inflation-induced increase in retained earnings ( $\pi_C$  times the book value of equity) (3a), estimate the nominal

cash flow not affected by inflation-induced deviations between accrual- and cash-based effects (3b), deflate this estimated nominal cash flow to the real cash flow (4), and omit the inflation induced increase of the retained earnings and the taxation of the inflation-induced increase in company value (5).

Steps 1 and 2 adjust the denominator from  $r_N$  minus  $\pi_C$  as applied by the auditors to  $r_R$ . Steps 3a and 3b transform the reported (accrual-based) nominal cash flow to a nominal cash flow not distorted by inflation-induced deviations between accrual- and cash-based effects. Steps 4 and 5 transform this nominal cash flow to the real cash flow without inflation induced tax effects.

Steps 3a and 3b deserve a closer look. For illustration, we use the example used in Schwetzler (2022b). The only driver of growth in the example is inflation (5%). This is comparable to our setting, because we do not address expansion-induced growth in our paper based upon the assumption that this part of growth is value neutral. The FCF with an inflation rate of zero can be interpreted as being the real FCF: 10.5. The nominal FCF is 9.25 in  $t=1$ . The difference between earnings after tax (12.6) and nominal FCF (9.25) is 3.35. It is due to two effects: There is an increase in net working capital (NWC) in nominal terms, which does not occur in real terms. If the NWC consists of accounts receivable only, it increases because accounts receivable from previous sales that are paid by customers in  $t=1$  are smaller than new accounts receivables resulting from new, inflated revenues (in the example: 1.1, equal to the beginning balance of the NWC, 22, times the inflation rate, 5%). Secondly, replacement capex is higher (47.25) than the depreciation of previous investments (45) due to inflation. The inflation-induced increase in retained earnings ( $3.35 = 1.1 + 2.25$ ) is equal to the inflation rate (5%) times the book value of equity (67). Thus, step 3a would add back 3.35 to 9.25, equaling the earnings after tax of 12.6. Step 3a reverses the retention of earnings defined by inflation rate times book value of equity. It is inflation-induced, and FCF would equal the earnings in a world without inflation (and without real growth).

With step 3b we aim at deriving the nominal cash flow without the inflation-induced deviations from a cash-based accounting and taxation setting that need to be addressed to prepare the transition to the cash flow in real terms. There are two effects in that regard, which sum up to 1.775 in the example: One is a tax effect of 0.675 (corporate tax rate,  $\tau_C$ , 30% times the difference between replacement capex of 47.25 and the depreciation of 45). The second one is the inflation-induced change in NWC of 1.1. Because we already added back the inflation-induced increase in retained earnings of 3.35 in step 3a, we only need to subtract the difference between 3.35 and 1.775, i.e., 1.575. This is step 3b. As a result of 3a and 3b we have transformed the reported nominal cash flow (9.25) to the ‘undistorted’ nominal cash flow of 11.025. It is equal to the inflated real cash flow (10.5 times  $1.05 = 11.025$ ). Finally, we subtract the inflation-induced growth ( $10.5 \cdot 0.05 = 0.525$ ) in step 4. The resulting value is 10.5, the cash flow in real terms.

Due to a lack of data in the reports we need to set a pragmatic assumption for step 3b. We need to split up the inflation-induced increase in retained earnings into an estimation of the difference between capex and depreciation, which is assumed to cause the tax effect referred to above, and into an estimated increase in NWC. We try to solve this problem by using the relation of fixed assets to the sum of fixed

assets and net working capital (variable  $a$ ), using the sample of financial statements provided by the Deutsche Bundesbank.<sup>5</sup> We matched the industry for each company in our sample reports with the respective average ratio (2000–2019) for that industry in the sample of the Deutsche Bundesbank. Net working capital is defined as current assets without liquid funds minus current liabilities. We use the corporate tax rate for the steady-state, if available. If the rate is not available, we set it equal to 30%. Thus, for step 3b we subtract the following amount:

$$\pi_C E_{BVA} (1 - \tau_C) \tag{10}$$

For the numerical example, this leads to ( $a = 45/67 = (47.25 - 45) / 3.35 = 0.672$ ):

$$0.05 \cdot 67 \cdot 0.672 (1 - 0.3) = 1.575$$

Because all balance sheet items are supposed to grow by the inflation rate in that setting, variable  $a$  can be derived by either dividing the net investment of 2.25 by the total increase in retained earnings (3.35), or by dividing the beginning balance of the fixed assets (45) by the total assets (67). The latter can serve as a justification for our approach to estimate variable  $a$  empirically.

The reports provide incomplete information regarding the periodic level of interest-bearing debt and the change in debt for the steady state. Therefore, we set another pragmatic assumption by forgoing adjustments caused by debt financing.

We can expect a difference between the reported terminal value and the terminal value in a world without inflation, not only because the inflation rate implied by the nominal cost of capital differs from the company specific inflation rate regularly, but because of the other effects, too. As a simplification, assuming for steps 3a to 5 that those changes in the cash flow cause effective income taxes amounting to half of the personal income tax as in Schwetzler (2022a), we can sum up as follows:

$$\begin{aligned} TV_{\text{reported}} &= \frac{FIE_N}{r_N - \pi_C} \\ &\neq \frac{[FIE_N + \pi_C E_{BVA} (1 - 0.5\tau_I) - \pi_C E_{BVA} (1 - \tau_C) (1 - 0.5\tau_I) + \pi_C 0.5\tau_I TV_N (1 - 0.5\tau_I)] (1 + \pi_C)^{-1}}{r_R} \tag{11} \\ &= TV_R \end{aligned}$$

It should be noted that the difference between  $\pi_C$  and  $\pi$  not only influences the implied real growth rate addressed in (II), but also the difference between  $TV_R$  and  $TV_{\text{reported}}$ . For company specific rates below the expected general inflation rate, the implied real growth rate will be negative and  $TV_R$  will be higher than  $TV_{\text{reported}}$ . Thus, (II) and (III) provide two different perspectives on the implications of company specific inflation rates different from  $\pi$ .

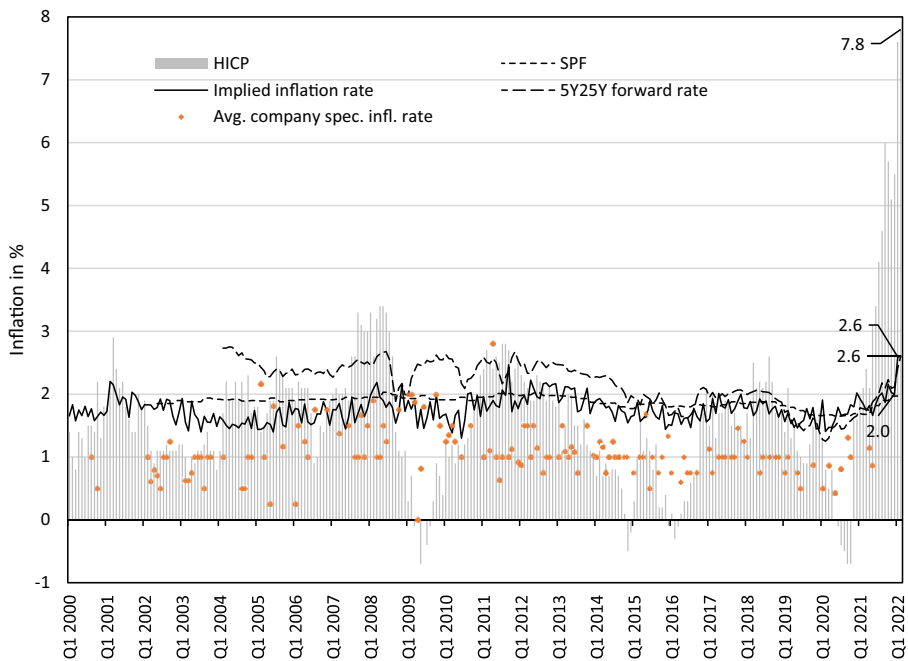
<sup>5</sup> The data is available at: <https://www.bundesbank.de/de/statistiken/unternehmen-und-private-haushalte/-/jahresabschlussstatistik-hochgerechnete-angaben-1997-bis-2020-827826>.

## 4 Empirical Results

### 4.1 Company Specific Inflation Rates Versus Expected Inflation Rates

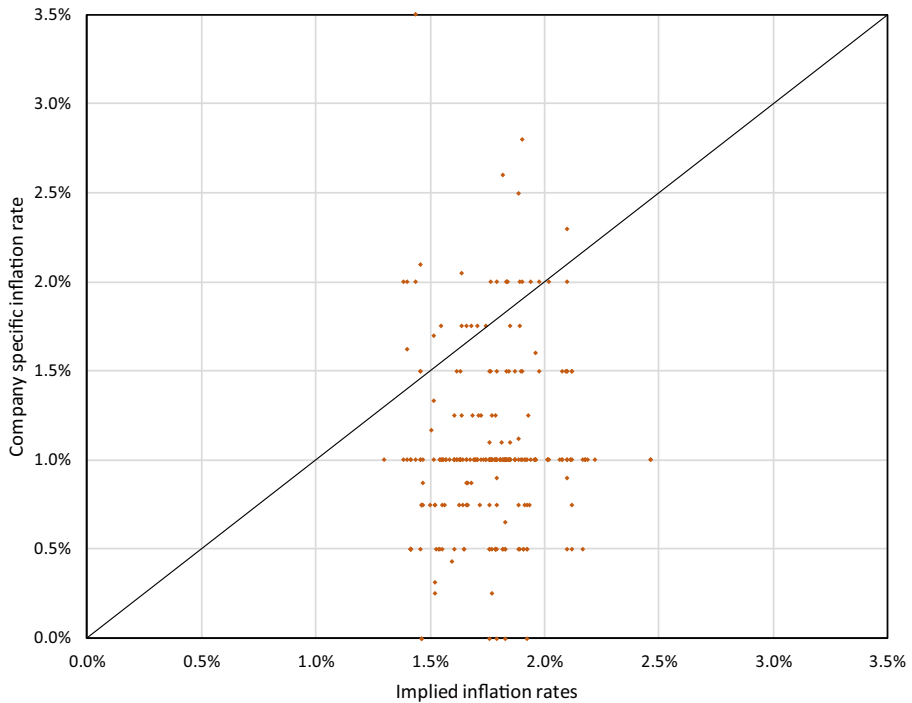
As described in Sect. 3.3, we use three proxies for the general expected inflation rate at the valuation date: the results of the Survey of Professional Forecasters, the inflation rate implied by the difference between nominal and real interest rates, and inflation swaps. Figure 1 depicts the development of these estimators of expected inflation and the actual inflation rates according to the *Harmonised Index of Consumer Prices* (HICP) provided by the Deutsche Bundesbank.

Figure 1 shows that actual inflation rates are far more volatile than expected inflation rates. For instance, the HICP was at  $-0.7\%$  in July of 2009, but rose to  $7.8\%$  in April 2022. In contrast, the expected inflation according to the SPF fluctuates between a minimum of  $1.65\%$  and a maximum of  $2.03\%$  over the sample period (std. dev.:  $0.09\%$ ). The last available value from Q1 2022 is close to its all-time high ( $1.97\%$ ). Expectations based upon implied inflation rates range between  $1.3\%$  and



**Fig. 1** Actual and expected inflation from 2000 to 2022. HICP: Harmonised Index of Consumer Prices; SPF: average long-term inflation expectation according to the Survey of Professional Forecasters (starting July 2002); implied inflation rate: rates implied by the difference between nominal and real interest rates derived from German government bonds with a remaining maturity of 10 years; 5Y25Y forward rate: inflation expectation in 5 years over the following 25 years calculated from 5-year and 30-year inflation swaps (starting April 2004); average company specific inflation rate is the mean company specific growth rate (until 2004) or company specific inflation rate (since 2005) of the valuations carried out in the respective month. Monthly data beginning of March 2000 until the end of March 2022; Q1 refers to the end of the first quarter





**Fig. 2** Distribution of company specific growth rates (until 2004) or company specific inflation rates  $\pi_C$  (since 2005) for the sample of 263 company valuation reports vs. expected inflation rates implied by real interest rates. Mode: 1.0% ( $\pi_C$ )/1.4% (expected inflation); mean: 1.0%/1.8%; median: 1.0%/1.8%; std. dev.: 0.5%/0.2%

2.75% (std. dev.: 0.24%). The expectations according to inflation swaps are higher than the other estimators most of the time (max.: 2.75%; min.: 1.25%; std. dev.: 0.35%) (see also Deutsche Bundesbank 2014, p. 75, 2015, pp. 46–47).

Based upon these expectations and our analysis of the valuation reports, we compare the expected rates with the company specific growth rates (until 2004) or company specific inflation rates (since 2005) that were used by the auditors at the valuation date. We contrast the expected inflation rates implied by the difference between nominal and real interest rates with the company specific rates in Fig. 2.<sup>6</sup> The observed combinations of the inflation rates are predominantly located beneath the bisecting line, i.e., the rates used for the purpose of company valuation are lower than the long-term expectations regarding inflation at the valuation date. The company specific rates exceed expected inflation rates only for 29 cases, i.e., for

<sup>6</sup> This figure is very similar to those for the other two inflation expectation proxies (SPF, swaps), not shown here. We only show the figure for the implied expected inflation, since they show a bigger variation than the point estimates of the SPF and are also available for the whole sample, which is in contrast to the ones implied by swaps. However, this is no recommendation in favor of this estimator for expected inflation.

11% of all 263 cases, and are set at 1% in 127 cases ( $n=263$ ). Regarding the other estimates, the results are even more distinct: For the inflation expectations derived by the SPF and inflation swaps, only 21 of the 250 valuations (8%) and 6 of 194 (3%) valuations apply company specific rates that surpass expected inflation rates respectively.

Company specific inflation rates show only a modestly positive, statistically significant correlation with expected inflation rates estimated by the SPF and inflation-linked swaps of 0.195 and 0.252, respectively. For the implied inflation rate, the correlation coefficient of 0.083 is statistically insignificant. This illustrates that company specific inflation rates react to only a rather limited extent to changes in expected inflation.

## 4.2 Incomplete Passing on of Increasing Input Prices (I)

Since company specific inflation rates are smaller than expected inflation rates for the majority of the cases, and some reports mention (without any specific data) problems to pass on inflationary effects on input prices to customers, we take a closer look at this problem in an indirect way by applying the measures developed in Sect. 3.4, Part I. Table 2 reports the years in which the nominal cash flow begins to decrease ( $t'$ ), and the years in which the nominal cash flow becomes negative ( $t''$ ), if the company were not able to pass on inflation completely ( $d < 1$ ). We exclude financial service providers for the analysis shown in Table 2, because the interpretation of cash inflows as revenues and cash outflows as the difference between revenues and EBIT does not suit these companies well. Independent of the estimator for expected inflation, cash flow starts to decrease in the first period immediately for more than half of the cases, if the company can only pass on 90% or less of inflation to its customers. If inflation can be transferred to customers by 95%, the subsequently higher cash inflows lead to average values between 134 and 148 years. However, the findings indicate a strong influence of extreme values, as the median values only vary between 46 and 52 years.  $t''$  has to exceed  $t'$  on average, since the nominal cash flow usually will not be negative for the same period it starts to decrease. Mean and median differ substantially for  $t''$ , too. Mean values for  $d=0.9$  vary between 89 and 100 years, while the median values fluctuate between 49 and 54 years. Overall, the results for  $t'$  and  $t''$  highlight the importance of addressing inflation consistently and question the going-concern assumption, if price increases on input factors could not be compensated by corresponding prices of the company's output. If going-concern is questionable, one could take the option to liquidate into account.

## 4.3 Company Specific Inflation Rates Below Expected Inflation Rates (II)

### 4.3.1 Implications for the Cash Flow Development

The results for  $t^*$ , i.e., the period in which the nominal cash flow is  $x\%$  of the beginning cash flow, are presented in Table 3. On average, the time until the cash flow is only 50% of its initial value is between 86 and 120 years. Median values show a lower result with approximately 63 to 87 years. On average however, a decline in  $x$

**Table 2** Critical period  $t'$  in which the nominal cash flow starts to decrease, if the company were not able to pass on inflation completely ( $d < 1$ ); Critical period  $t''$  in which the nominal cash flow becomes negative, if the company were not able to pass on inflation completely ( $d < 1$ );  $n$  in Table 2 differs from the number of observations ( $n$ ) in Table 5, which is based on the highest possible number of observations, because CI and CO in the first year of the steady state are not given in all reports. Financial service providers are excluded from this analysis

d		0.95	0.9	0.85	0.8	0.75
<i>Survey of Professional Forecasters (SPF)</i>						
$t'$	n	191	191	191	191	191
	$t' = 1$	48	112	143	156	166
	Mean	139.1	53.2	29.4	18.8	13.0
	Median	45.9	1.0	1.0	1.0	1.0
	Std. dev	269.6	129.3	80.9	56.5	41.7
$t''$	n	191	191	191	191	191
	Mean	188.3	94.1	62.7	47.0	37.6
	Median	100.7	50.3	33.5	25.1	20.1
	Std. dev	272.3	136.1	90.7	68.0	54.3
<i>Implied inflation rates</i>						
$t'$	n	197	197	197	197	197
	$t' = 1$	49	114	147	161	171
	Mean	147.5	56.1	30.8	19.5	13.5
	Median	52.2	1.0	1.0	1.0	1.0
	Std. dev	280.6	134.5	84.0	58.5	43.0
$t''$	n	197	197	197	197	197
	Mean	200.5	100.2	66.8	50.1	40.0
	Median	107.4	53.7	35.8	26.8	21.4
	Std. dev	283.5	141.7	94.4	70.8	56.6
<i>Inflation swap</i>						
$t'$	n	160	160	160	160	160
	$t' = 1$	35	87	115	128	136
	Mean	134.3	51.6	28.5	18.2	12.7
	Median	45.6	1.0	1.0	1.0	1.0
	Std. dev	243.3	117.1	73.4	51.2	37.8
$t''$	n	160	160	160	160	160
	Mean	178.5	89.2	59.4	44.5	35.6
	Median	97.7	48.8	32.5	24.4	19.5
	Std. dev	245.7	122.8	81.8	61.3	49.0

of 15% to 85% can be observed already 20 to 28 years after the valuation (Median: 15 to 20 years).  $t^*$  calculated with inflation swaps is lower than  $t^*$  for the other two estimators, because the swap-based expected inflation rates are often higher than the expected rates based upon the SPF survey and the also survey-based implied inflation rates over the sample period (see Fig. 1). The reason for the decrease in cash flows is that company specific inflation rates are smaller than inflation rates expected at the valuation date. This is also illustrated by Fig. 2. As mentioned already, a company to be valued will be subject to a specific mix of different inflationary effects in the

**Table 3** Critical period  $t^*$  in which the nominal cash flow is  $x\%$  of the beginning cash flow, if  $\pi_C < \pi$ ;  $n$  in Table 3 differs from the number of observations ( $n$ ) in Table 5, because not all  $\pi_C$  are smaller than  $\pi$  and financial service providers are not excluded from this analysis

$t^*$	$x$	0.95	0.9	0.85	0.8	0.75	0.6	0.5
<i>Survey of Professional Forecasters (SPF)</i>								
	$n$	226	226	226	226	226	226	226
	Mean	7.7	15.7	24.3	33.3	43.0	76.3	103.5
	Median	5.8	11.9	18.3	25.2	32.4	57.6	78.1
	Std. dev	12.3	25.3	39.0	53.6	69.0	122.6	166.3
<i>Implied inflation rates</i>								
	$n$	230	230	230	230	230	230	230
	Mean	8.9	18.3	28.2	38.7	49.8	88.5	120.1
	Median	6.4	13.2	20.3	27.9	36.0	63.9	86.7
	Std. dev	17.0	34.8	53.7	73.8	95.1	168.8	229.1
<i>Inflation swap</i>								
	$n$	192	192	192	192	192	192	192
	Mean	6.3	13.0	20.1	27.6	35.6	63.2	85.7
	Median	4.7	9.6	14.8	20.3	26.1	46.4	63.0
	Std. dev	10.1	20.7	31.9	43.8	56.5	100.4	136.2

markets for input and output factors relevant for this company. For a rather large sample of valuation reports covering a long time span and a number of industries (see Table 1), one could argue that the average of the company specific inflation rates has to be closer to expected general inflation rates, and that more company specific rates should exceed the expected inflation rates.

#### 4.3.2 Implied Real Growth Rate

We solve Eq. 1 for the implied real growth rate, if the company specific rate were a nominal growth rate. Table 4 shows the results for all three estimated inflation rates.

**Table 4** Implied real growth rate  $g^*$ . Company specific rate  $\pi_C$  deflated by the inflation expected at the valuation date for all three proxies for the expected inflation at the beginning of the steady-state

	$g^*$		
	SPF	Implied inflation rates	Inflation swaps
Minimum	-2.0%	-1.9%	-2.3%
25%-quantile	-1.0%	-1.0%	-1.4%
Mean	-0.8%	-0.7%	-1.1%
Median	-0.9%	-0.8%	-1.1%
75%-quantile	-0.7%	-0.5%	-0.8%
Maximum	1.6%	2.0%	0.9%
Std. Dev	0.5%	0.5%	0.5%
$n$	250	263	194
$n$ with rate $< 0$	229	234	188

**Table 5** Inflation-induced value effects

Estimator	SPF			Implied inflation rates			Inflation swaps					
	$\Delta TVa$	$\Delta TVb$	$\Delta Ea$	$\Delta Eb$	$\Delta TVa$	$\Delta TVb$	$\Delta Ea$	$\Delta Eb$	$\Delta TVa$	$\Delta TVb$	$\Delta Ea$	$\Delta Eb$
Valuation	-19.3%	-20.6%	-13.6%	-14.4%	-23.3%	-24.8%	-16.3%	-17.4%	-13.0%	-13.7%	-13.0%	-13.7%
Minimum	7.1%	7.8%	5.3%	5.8%	6.5%	7.1%	4.5%	5.0%	9.6%	10.8%	7.8%	8.6%
25%-quantile	15.6%	16.6%	12.7%	13.5%	13.6%	14.5%	11.0%	11.7%	21.5%	22.9%	18.0%	19.1%
Mean	14.3%	15.4%	11.3%	12.0%	13.7%	14.6%	10.3%	11.0%	18.1%	19.5%	14.7%	15.7%
Median	22.7%	23.9%	17.2%	18.1%	19.8%	20.9%	16.1%	17.1%	29.2%	30.5%	23.4%	24.8%
75%-quantile	78.2%	80.6%	69.7%	71.4%	81.2%	83.7%	68.0%	69.3%	107.4%	111.8%	91.6%	95.3%
Maximum	13.0%	13.5%	11.4%	11.8%	12.1%	12.7%	10.3%	10.8%	17.4%	18.1%	15.2%	15.8%
Std. Dev	250	250	250	250	263	263	263	263	194	194	194	194
n	226	227	226	227	232	233	232	233	186	187	186	187
$\Delta E > 0$	90.4%	90.8%	90.4%	90.8%	88.2%	88.6%	88.2%	88.6%	95.9%	96.4%	95.9%	96.4%

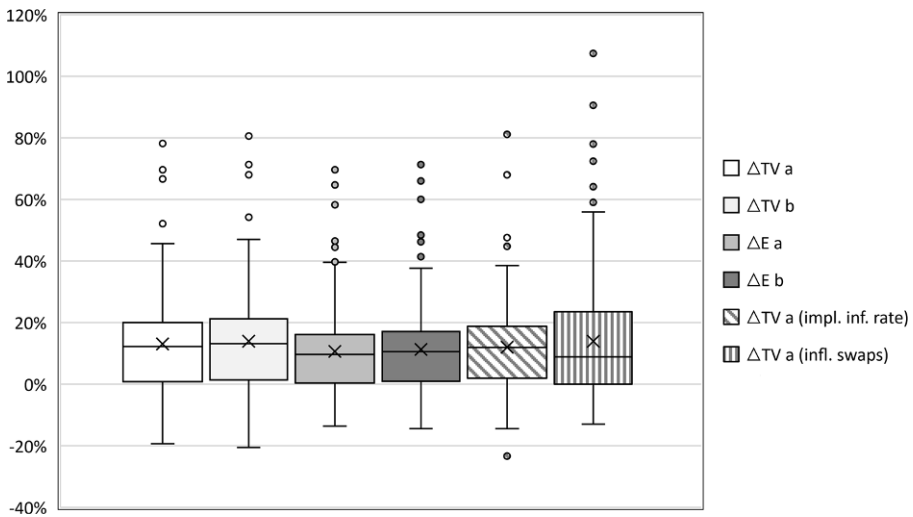
$\Delta TVa$ : difference between the terminal value when using the expected inflation rates and the reported terminal value using the company specific rate, in % of reported terminal value;  $\Delta TVb$ : difference in terminal value after deflating FIE by  $\pi_C$  and inflating it by  $\pi$ ;  $\Delta Ea$ : difference in the value of equity at the valuation date in %;  $\Delta Eb$ : difference in the value of equity after deflating FIE by  $\pi_C$  and inflating it by  $\pi$ . All mean values are statistically different from zero and the other proxy's corresponding mean values at the 0.1%-level (t-test)

The implied real growth rates are negative for most valuations. This is not surprising, because the company-specific inflation rates are mostly smaller than the expected general inflation rate. The average implied real growth rate is negative, too. Thus, common valuation practice implies shrinking real cash flows on average and also for the majority of the valuations. In addition, these observations do not support the interpretation that the company specific growth rate does contain (positive) real growth. They instead indicate that it should be interpreted as being inflation-induced.

#### 4.3.3 Implications for Company Values

In order to give an indication regarding the value effects when using a company specific inflation rate that differs from the general expected inflation rate, we substitute the latter for the former, with regard to the steady state as described above. Table 5 shows the results of our analysis for all variables and for all estimators for expected inflation.

We can observe considerable value effects resulting from using company specific inflation rates below expected inflation rates. The mean (median) differences in terminal value in % of the reported terminal value vary between 13.6% (13.7%) and 21.5% (18.1%) with no additional inflation adjustment of the cash flow in the first year of the perpetuity ( $\Delta TV_a$ ).  $\Delta TV_b$  exceeds  $\Delta TV_a$  on average for all indicators, since the company specific rates are usually lower than the inflation expectations



**Fig. 3** Box plots of differences in terminal value and the value of equity at the valuation date in % of the respective reference value using the average long-term (five years ahead) euro area annual HICP inflation point estimate from the Survey of Professional Forecasters (SPF) as a proxy for inflation expectation at the valuation date. All mean values are statistically different from zero and the other inflation estimators' corresponding mean values at the 0.1%-level (t-test). Boxes mark the 25%- and the 75%-quantile with mean (cross) and median (line) values included; points mark outliers that exceed the respective quantile by 1.5 times the inter-quartile range

at the valuation date, which causes the inflation adjustment of the cash flows to be positive. The difference in the value of equity at the valuation date, which includes the (unchanged) present value contribution of the cash flows expected to be generated prior to the steady state, in % of the reference value of equity ( $\Delta E_a$ ) is positive, too, with mean (median) values between 11.0% (10.3%) and 18.0% (14.7%). We observe that value effects arising from using company specific growth rates/company specific inflation rates that differ from inflation expectations at the valuation date lead to a lower terminal value and a lower value of equity at the valuation date for the majority of cases. One should note that our results tend to underestimate the effect on the value of equity at the valuation date. The reason is that the value of equity at the valuation date, if expected inflation rates were used, would be higher than calculated in our analysis due to our assumption to not adjust the levered cost of equity for discounting from the steady state to the valuation date because of incomplete data. The levered cost of equity should be lower due to a higher terminal value (of equity) leading to an even higher reference value of equity. Again, our results do not allow the conclusion that a company specific rate may not be smaller than the expected general inflation rate for specific cases. Figure 3 illustrates the value effects by using box plots.

#### 4.4 Deviation from the Terminal Value in a World Without Inflation (III)

Table 6 shows the difference between the terminal value in a (hypothetical) world without inflation and the reported nominal terminal value ( $TV_R - TV_{\text{reported}}$ ) in % of the reported terminal value in total (cumulative effect) as well as the value effect for each of the 5 steps. Besides showing the results for the entire sample, we also show the results for subsamples, which we defined according to the data provided in the reports.

First, we show the average ceteris paribus-effects in % of reported terminal value, the exemption being step 2, because this adjustment, leading to a denominator of  $r_{L,R}$  minus  $\pi_C$ , should not be interpreted on a stand-alone basis due to a lack of economic meaning. Steps 1 and 2 combined (replacing nominal cost of capital minus  $\pi_C$  with real cost of capital) have the largest impact. Step 1 leads to a c.p.-value decrease, step 2 to a c.p.-value increase. Skipping the inflation-induced increase in retained earnings changes the terminal value by +8.5% on average (step 3a). Step 3b and deflating the FtE at the beginning of the steady state (step 4) as well as the taxation of inflation-induced value increases (step 5) have a relatively small impact on average. For 136 valuations (subsample A), effects 1, 2 and 4 apply. 77 valuations (subsample B) also use the inflation-induced increase in retained earnings (step 3a), and for only 31 cases all 5 steps are relevant (subsample C). We cross-checked our results with the results in Schwetzler (2022a) who reports a deviation based solely upon steps (1) and (3a) between reported and adjusted terminal value in % of *adjusted* terminal value of 12.1%. The ceteris paribus-effect is -16.2% for step 1 and 8.5% for step 3a, as shown in Table 6, both in % of the *reported* terminal value. The combined effect is -12.8% (not shown in Table 6). Provided that we define this effect as the difference between adjusted and reported terminal value in % of reported terminal value, we need to use the reciprocal value of  $1 + \text{change in}$

value for a comparison. The corresponding change in terminal value is 15.6%. The remaining difference to the 12.1% according to Schwetzler (2022a) must be due mainly to the differences in the samples. Schwetzler (2022a) uses a smaller sample that also includes banks and insurance companies.

Company value in a world with inflation deviates from company value in a world without inflation, inter alia because company specific inflation rates differ from the expected inflation rate regularly. Cash flow grows by  $\pi_C$ , while the discount rate

**Table 6** 5 steps from reported nominal terminal value to a terminal value in a (hypothetical) world without inflation: ‘Change in value ceteris paribus’ represents the effect of one single step. ‘Cumulated change in value’ represents the effects when cumulating all relevant value effects

	1. w/o $\pi_C$	2. w/o $\pi_C$ & $\pi_{LR}$	3. a. w/o $RE_{INF}$	3. b. w/o acc	4. FtE / (1 + $\pi_C$ )	5. w/o $Tax_{INF}$
<b>Change in value ceteris paribus</b>						
Minimum	-40.7%	-20.1%	0.2%	-8.7%	-3.4%	0.8%
25%- quantile	-19.2%	14.9%	3.4%	-2.8%	-1.1%	1.8%
Mean	-16.2%	21.4%	8.5%	-2.0%	-1.1%	2.5%
Median	-15.4%	20.7%	7.0%	-1.4%	-1.0%	2.3%
75%- quantile	-12.0%	27.8%	11.9%	-0.8%	-0.9%	3.1%
Maximum	-3.1%	81.5%	39.9%	-0.1%	-0.2%	6.1%
Std. Dev	6.4%	13.6%	6.8%	1.6%	0.5%	1.2%
n	245	250	108	108	245	32
No effect	5	0	142	142	5	218
<b>Cumulated change in value</b>						
Minimum	-40.7%	-20.1%	-15.4%	-16.9%	-19.7%	-19.7%
25%- quantile	-19.2%	14.9%	16.8%	16.3%	15.1%	15.2%
Mean	-15.9%	21.4%	25.9%	24.9%	23.6%	24.0%
Median	-15.4%	20.7%	24.6%	23.3%	22.0%	22.4%
75%- quantile	-11.7%	27.8%	32.4%	31.3%	30.0%	30.6%
Maximum	0.0%	81.5%	121.3%	115.4%	113.8%	119.4%
Std. Dev	6.7%	13.6%	16.5%	15.8%	16.0%	16.3%
<b>Cumulated change in value for subsamples</b>						
<i>Subsample A: Steps 1, 2 and 4</i>						
Minimum	-40.7%	-12.9%			-15.1%	
25%- quantile	-18.1%	15.9%			14.6%	
Mean	-15.2%	22.1%			21.0%	
Median	-14.6%	20.7%			19.5%	
75%- quantile	-10.9%	28.8%			27.5%	
Maximum	-3.1%	81.5%			80.6%	
Std. Dev	6.4%	13.3%			13.6%	
n	136	136			136	



**Table 6** (Continued)

	1. w/o $\pi_C$	2. w/o $\pi_C$ & $r_{LR}$	3.a. w/o $RE_{INF}$	3.b. w/o acc	4. FtE / $(1 + \pi_C)$	5. w/o $Tax_{INF}$
<i>Subsample B: Steps 1 through 4</i>						
Minimum	-37.4%	-20.1%	-15.4%	-16.9%	-19.7%	
25%-quantile	-19.4%	10.1%	18.5%	17.2%	15.8%	
Mean	-17.1%	18.0%	28.1%	25.8%	24.4%	
Median	-16.6%	19.3%	27.0%	25.1%	23.8%	
75%-quantile	-13.8%	23.8%	34.4%	31.4%	30.1%	
Maximum	-5.4%	48.8%	90.7%	83.7%	81.9%	
Std. Dev	5.9%	11.7%	16.2%	15.5%	15.7%	
n	77	77	77	77	77	
<i>Subsample C: Steps 1 through 5</i>						
Minimum	-34.9%	-11.4%	-3.8%	-6.5%	-9.1%	-3.8%
25%-quantile	-20.8%	17.8%	26.6%	24.4%	22.7%	26.2%
Mean	-17.6%	25.3%	36.5%	33.9%	32.6%	35.6%
Median	-16.9%	23.1%	33.2%	30.7%	29.4%	32.3%
75%-quantile	-13.2%	30.0%	39.2%	37.4%	36.2%	38.6%
Maximum	-7.0%	71.3%	121.3%	115.4%	113.8%	119.4%
Std. Dev	6.8%	17.1%	23.8%	22.6%	22.7%	23.0%
n	31	31	31	31	31	31

1. w/o  $\pi_C$ : no inflation-induced growth in the denominator; 2. w/o  $\pi_C$  &  $r_{LR}$ : no inflation-induced growth in the denominator and real cost of capital instead of nominal cost of capital; 3.a. w/o  $RE_{INF}$ : no inflation-induced increase in retained earnings; 3.b. w/o acc: no inflation-induced deviations between accrual- and cash-based effects; 4. FtE /  $(1 + \pi_C)$ : inflation-induced cash flow adjustment; 5. w/o  $Tax_{INF}$ : no taxes on inflation-induced increase in value. Step 2 is only shown together with step 1. Subsample A: steps 1, 2, 4 only; Subsample B: steps 1 through 4; Subsample C: all steps. The sample size ( $n = 250$ ) and the calculations for the effect  $r_{LR}$  are based on the availability of the average long-term (five years ahead) euro area annual HICP inflation point estimate from the Survey of Professional Forecasters (SPF). 5 cases include a company specific inflation rate of zero and are excluded from subsample A; one case includes all effects except  $RE_{INF}$  and is excluded from subsample C

contains the general inflation rate  $\pi$ , which is higher than the company specific inflation rate for most of the cases. As a consequence, steps 1, 2, and 4 do not sum up to zero. In addition, steps 3a and 3b constitute another deviation. And finally, step 5 does so too. Beyond the scope of our paper, one might argue that using Eq. 2 to transform the nominal cost of capital after income taxes into the real cost of capital after income taxes needs to be analyzed further with regard to the income tax effect on capital gains implied in its definition. Table 6 illustrates the increasing difference between adjusted and reported terminal value, if steps 3a and 3b as well as step 5 are considered. The mean effect increases from 21.0% (subsample A) to 24.4% (subsample B) and to 35.6% (subsample C). Although a part of the difference for subsample C can be traced back to the differing values for steps 1, 2 and 4 (A: 21.0%, B: 16.7%; C: 23.3%; B & C not shown in Table 6), one might argue that especially

steps 3a and 3b cause a respectable difference in value changes for subsamples B and C compared to A.

## 5 Conclusions

For this paper, 263 valuations with a valuation date between 2000 and 2021 were reconstructed and analyzed in order to learn more about how inflation is dealt with in practice. We use three different estimators for expected rates of inflation: expected long-term inflation from the quarterly Survey of Professional Forecasters, the inflation rate implied by comparing real and nominal interest rates reported by the German Bundesbank that equals a retrograde estimation of the survey of Consensus Estimates Inc. (implied inflation rate), and the inflation-linked swap rates provided by Bloomberg on a daily basis (inflation swap).

Based upon the observation that company specific inflation rates assumed for the steady state are lower than the expected general inflation rates, we use three approaches to analyze its implications:

- I. Since a limitation to pass on price increases on input factors to customers is mentioned in some reports, we analyze how this limitation would diminish future cash flows. For doing so, we assume varying degrees of the severity of these struggles. A deficit to pass on inflation of 15% (i.e.,  $d=0.85$ ) would already lead to decreasing EBIT after about 28 to 31 years, and to negative EBIT after about 59 to 67 years (depending upon the estimator for expected inflation). That illustrates the vulnerability of a cash flow forecast to this problem. The single company specific inflation rate usually applied in valuation reports should be the result of the company's ability to deal with price increases on input factors and of specific inflation effects on different streams of cash inflows and cash outflows. This makes it unlikely that the company specific inflation rate remains constant in the steady state, putting the use of the usual growth formula into question. The composition and the development of the company specific inflation rates, and the consequences of not being able to pass on inflationary effects should be analyzed thoroughly by valuation practitioners. This includes not only a justification of the level of the company specific rate, but also a clear distinction between inflation-induced and expansion-induced growth.
- II. As a company to be valued is subject to price changes in all relevant input and output markets, inflation is company specific. However, one can make a convincing argument that for the large sample of valuations analyzed in this paper, the average company specific inflation rate should be at least close to the expected overall inflation rates. Our analysis shows that this is not true. On average, company specific inflation rates are lower than expected inflation rates. They even show only a weak, if any, positive correlation with expected inflation. This implies a negative real growth rate on average (mean:  $-0.7\%$  to  $-1.1\%$ ), and company values are on average smaller than they would be, if expected inflation rates were used. Put differently, there should be more companies than the 3% to 11% that are expected to generate an inflation-induced rate of growth above the ex-

pected overall inflation rate. We quantify the difference between adjusted and reported terminal value in % of the reported terminal value (mean: about 14% to 22%; median: about 14% to 18%) as well as the difference in the value of equity at the valuation date (mean: about 11% to 18%; median: about 10% to 15%), if the general expected inflation rate is used instead of the company specific rate. Despite these aggregated results, company specific rates may be smaller than the general expected rate for quite a few companies.

- III. The difference between the reported nominal terminal value and the terminal value in a (hypothetical) world without inflation, measured in % of reported terminal value, depends upon how many inflation-related effects have been used by the valuator. For the entire sample, its mean is 24% (median: about 22.4%) of reported terminal value. Again, it is caused inter alia by the discrepancy of the overall expected inflation being part of the RADR and the (on average) lower company specific inflation rate assumed for the cash flow forecast.

Inflationary effects on cash inflows and cash outflows deserve a more detailed analysis in company valuations. A company's specific inflation rate can be smaller than the expected general inflation rate. However, we argue that this should not be the case on a regular basis or on average respectively. One should also note that a company specific rate results from possibly differing inflation expectations in the markets the company is operating in. This challenges the usual assumption that the company specific inflation rate is constant, thereby also challenging the use of the perpetuity formula after a detailed cash flow forecast for a few years. Furthermore, applying a nominal RADR that implies the general expected inflation rate to cash flows written forward by a different rate, also questions the assumption of NPV-neutral reinvestments. Finally, one should note that our results, which are not negligible in terms of size, stem from a period of time when expected inflation has been considerably lower than recently. Inflation-induced value effects will increase, if a company's specific inflation rate is not adjusted to higher expectations about future inflation.

## 6 Appendix

Derivation of Eq. 6 (see Schüler and Lampenius (2007)):

$$\begin{aligned}
 (1 + d\pi_C) \frac{C I_{t'-1}}{F T E_{t'-1}} - (1 + \pi_C) \frac{C O_{t'-1}}{F T E_{t'-1}} - 1 &= 0 \\
 (1 + d\pi_C) C I_{t'-1} - (1 + \pi_C) C O_{t'-1} &= F T E_{t'-1} \\
 d\pi_C C I_{t'-1} - \pi_C C O_{t'-1} &= 0 \\
 d\pi_C C I_0 (1 + d\pi_C)^{t'-1} &= \pi_C C O_0 (1 + \pi_C)^{t'-1} \\
 \ln(d\pi_C C I_0) + (t' - 1) \ln(1 + d\pi_C) &= \ln(\pi_C C O_0) + (t' - 1) \ln(1 + \pi_C) \\
 (t' - 1) \ln \frac{(1 + \pi_C)}{\ln(1 + d\pi_C)} &= \ln \left( \frac{d\pi_C C I_0}{\pi_C C O_0} \right) \\
 t' = 1 + \ln \frac{d\pi_C C I_0}{\pi_C C O_0} \cdot \left( \ln \frac{1 + \pi_C}{1 + d\pi_C} \right)^{-1} &\forall t' \geq 1 \\
 t' = 1 + [\ln(dC I_0) - \ln(C O_0)] \cdot \left( \ln \frac{1 + \pi_C}{1 + d\pi_C} \right)^{-1} &
 \end{aligned}$$

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