Stock market valuations – theoretical basics and enhancing the metrics

With stock market volatility high, public debate has recently returned to the question of whether the current stock market valuation is appropriate. Developments in stock market valuations are also of interest from a monetary policy and financial stability angle. Dividend discount models, which are based on interest rates and dividend expectations and allow the implied cost of equity and equity risk premiums to be derived, provide a theoretical basis for investigating the appropriateness of the valuation level. Essentially, these models attribute movements observed in equity prices to changes in the individual model components. However, by providing the implied cost of equity and equity risk premiums, dividend discount models deliver more than just a gauge for stock market valuations and market players' attitude to risk. Developments in individual model components also help assess the broader economic environment for corporates. The present article takes the usual valuation approaches a step further by focusing on maturity-specific interest rates and analyst dividend expectations. As measured by the implied cost of equity, the DAX's valuation was slightly below its ten-year average at the end of March 2016. By contrast, the equity risk premium was comparatively high, at 7½%, and close to the implied cost of equity. The small gap between these two metrics is probably mainly due to the current low-interest-rate environment. Moreover, it should be noted that the valuation level and the assessments derived therefrom are based on the assumption that the survey-based earnings and dividend forecasts correctly reflect market expectations, which need not necessarily be the case. The dividend discount model metrics should therefore not be looked at in isolation, they should be seen as components of a broad indicator approach.

Introduction

Volatility of stock market raises questions about its valuation level

Having risen almost continuously between mid-2012 and mid-2015, the stock markets on both sides of the Atlantic suffered sharp losses in the second half of 2015 and then entered choppy waters. Prices have been very volatile since then, which was reflected in heightened implied volatility and suggests that market participants are uncertain as to how prices will develop going forward. In February 2016, stock market valuations reached a two-year low, from which they have since recovered somewhat. The recent phase of heightened volatility on the international equity markets raises the question, from a monetary policy and financial stability perspective, of what valuation is appropriate. Against this backdrop, the present article explores forward-looking risk indicators that help put price levels into perspective. They may suggest that price movements on the stock market are driven by high market uncertainty, monetary policy, safe haven flows or the search for yield. Looking at stock market valuations is therefore an integral part of the Bundesbank's ongoing economic analysis.

Simple metrics and the theoretical framework

Book values and realised earnings reflect the past, …

To gain a rough idea of a company's valuation, its share price is often divided by either the book value per share (price-book ratio) or the company's realised earnings per share (price-earnings ratio). The book value of equity essentially represents the proceeds of common stock issued in the past plus accumulated retained earnings. However, neither metric is forward-looking, and they are therefore of only very limited use when assessing current valuations.

… but future earnings key to a share's value

In a forward-looking analysis, a company's stock price should, by contrast, reflect the present value of all future dividends. Mathematically, this can be expressed through the dividend discount model's price equation:

$$P = \sum_{i=1}^{\infty} \frac{E(D_i)}{(1 + r_{E,i})^i} \ .$$

Dividend discount model with dividend forecasts …

This means that today's share price P equates to the present value of all future dividends $E(D_i)$ that market players expect the company to generate. As an enterprise is designed for perpetuity, a share has no fixed maturity, and all dividends expected in future are counted. Market players' dividend expectations may, for instance, be proxied by analysts' dividend forecasts. The discount rates $r_{E,1}$, $r_{E,2}$, $r_{E,3}$, … reflect the stock's valuation as compared to dividend expectations.

… allows valuation metrics to be determined

Assuming constant discount rates (pa) across all forecast horizons ($r_{E,1} = r_{E,2} = r_{E,3} = \ldots = r_E$), the discount rate equals the implied rate of return that investors require for a stock market investment and thus the company's implied cost of equity. The implied cost of equity r_E contains a risk-free interest rate plus an equity risk premium. The latter represents the excess return that investors require to cover the risk of a stock market investment for given dividend expectations and a given risk-free alternative investment. It can be equated to the additional return that equities offer over an investment in a safe asset.

Dividend discount model and price-earnings ratio

Under highly simplified assumptions, the implied cost of equity corresponds to the earnings yield: assuming that the expected dividend payments and the discount rates r_E are constants and that, moreover, the entire earnings are always paid out in full as dividends, the present value in the price equation of the dividend discount model "collapses" to yield the quotient of earnings and the implied cost of equity. In this special case, the implied cost of equity is called the earnings yield and equates to the inverse of the price-earnings ratio

$$earnings\ yield = \frac{1}{PE} \ .$$

In practice, the earnings yield is frequently calculated based on the earnings expected over

the next 12 months. When calculated in this manner, the metric is therefore forward-looking. However, it only takes into consideration a short forecast horizon for earnings.

Taking the dividend discount model a step further

As shown below, the dividend discount model can be rendered more accurate by modelling expected dividends more exactly (through analyst surveys, for instance) and by taking into account the yield curve of Federal securities (see the box on pages 20 and 21). If the forward-looking valuation approach is to deliver valid metrics, it is important that the input data on expectations are reliable. The quality of the data used for this purpose will, therefore, also be discussed below.

Monetary and financial stability policymakers interested in the market as a whole, not individual companies

Furthermore, monetary and financial stability policymakers are more interested in the valuation level of the equity market as a whole than that of individual stocks. This is because the valuation of individual enterprises tends to be of secondary importance from a monetary policy and financial stability angle, while the health of the market as a whole has a key role to play as an indicator for the overall economy.

Characteristics and quality of survey data

Survey participants and data quality

The earnings and dividend expectations used here are taken from analyst surveys.[1] The quality of the forecasts depends in large measure on the number of analysts taking part in the survey. This creates a conflict of priorities for equity analysis. From a macroeconomic perspective, it would be good to have a broad spectrum of companies. However, the number of analysts covering a company drops, the smaller that company is. Hence, for the 30 DAX companies, an average of between 20 and 30 analysts per company provide forecasts on the earnings and dividends expected in the next three fiscal years. In the broad Prime All Share index, which currently includes more than 300 German companies, there are, on average, only roughly ten analysts per company.[2] A comparison of aggregate forecasts at the index level shows that earnings and dividend estimates based on the information provided by just a few analysts per company are more susceptible to outlier forecasts by individual analysts. The aggregate forecasts for the Prime All Share index consequently have larger irregular fluctuations and a wider fluctuation range than the DAX. This is particularly true of the expected medium-term earnings growth rate in three to five years, for both Prime All Share and DAX enterprises. On average, fewer than five (Prime All Share) and between five and ten (DAX) analysts per company take part in these surveys.

Survey participants' behaviour

Another aspect affecting data quality is the frequency with which analysts adjust their forecasts of company figures. For DAX enterprises, for instance, fewer than half of all analysts update their forecasts within a month on average. The percentage is lower still for the Prime All Share index. This means that for companies in this index almost 30% of consensus forecasts have not been updated for a month. By contrast, the larger number of analysts covering DAX companies means that the consensus forecast at the index level is adjusted almost continuously.[3] New information on companies' fundamentals is therefore reflected in the DAX more quickly than in the Prime All Share, which is based on older estimates. After weighing up forecast quality and market coverage, the DAX index is therefore used in the following analyses.

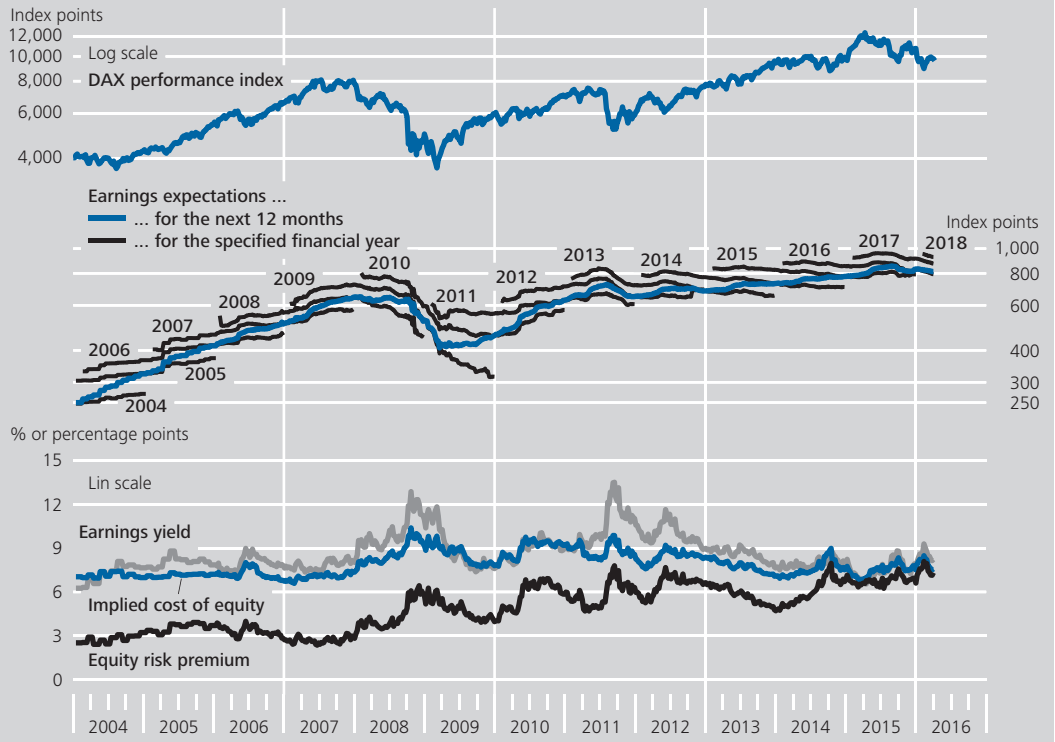
Share price developments and earnings expectations for the DAX

Assuming that surveys on earnings expectations adequately reflect conditions in the cor-

1 Source: Thomson Reuters Datastream (Institutional Brokers' Estimate System, I/B/E/S).
2 Looking at Europe, this also applies to a comparison of the broad Eurostoxx and Eurostoxx 50 indices.
3 In terms of the medium-term rate of earnings growth, however, the consensus forecast might remain unchanged for an extended period, even for the DAX.

DAX share price developments, earnings expectations and valuation indicators

Weekly data



Sources: I/B/E/S (Thomson Reuters Datastream), Consensus Economics and Bundesbank calculations.
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DAX share price developments and earnings expectations …

porate sector, earnings expectations and prices should be closely correlated. The above chart shows the evolution of the DAX as well as the earnings expectations for a 12-month horizon and for individual fiscal years. Analysts' fiscal-year forecasts are for the current and the two subsequent calendar years. Expectations for a horizon of 12 months are then interpolated from the surrounding fiscal years.

… move in parallel in the long term

Overall, earnings and prices move in parallel in line with theoretical reasoning. In the upturn preceding the financial crisis, earnings expectations were raised continuously, while they were revised down during the financial crisis, reflecting the sharp deterioration in the overall economic situation.

Relevance of fiscal-year forecasts

However, the earnings expected in 12 months appear to lag share price developments. In 2008, for instance, there was a delay before the drop in share prices was reflected in earnings expectations.[4] One reason for the lag is technical: earnings forecasts for fiscal years in the more distant future are generally higher than earnings expectations for the next few fiscal years. It is therefore possible that the 12-month earnings forecast rises because the weight of the more distant fiscal years increases over time, although the earnings or dividends forecasts were revised down for the individual fiscal years. Another example of this effect is what happened to earnings expectations between 2012 and 2014: on balance, the forecasts of earnings in 12 months' time rose, although the fiscal-year forecasts were revised down. In terms of stock market analysis, it is therefore important to look very carefully at expectations for earnings in the individual fiscal years. They may contain valuable information about a turnaround in sentiment, which is lost when converted into fixed forecast horizons.

4 See Deutsche Bundesbank, Corporate earnings and share prices, Monthly Report, July 2009, pp 15-28.

Backward-looking expectations formation suggests a potential distortion of expectations

There is, however, a lag – albeit a smaller one – even for the individual fiscal years. This may be due to the relatively small percentage of updated individual forecasts. Because not all analysts adjust their forecasts immediately, adjustment of the consensus forecast may be delayed. Moreover, there is evidence to suggest that analysts' expectations formation is backward-looking. Instead of promptly factoring all available information into their earnings forecasts, analysts appear to draw up new forecasts based in part on past forecast errors. A recent study on US banks shows that analysts' forecast error depends on known information, a phenomenon that was particularly pronounced during the 2008-10 financial crisis, and thus does not reflect only new events (economic shocks).[5] The forecast error depends on past adjustments to expectations, which may be another potential reason for the lag in forecasts. Such backward-looking expectations formation may be plausible, especially in times when analysts' uncertainty regarding their own forecast model is heightened or the information situation is unclear. This may also be reflected in a broader dispersion of analyst estimates, which was in fact the case between 2008 and 2010. It should therefore be noted that the empirically calculated equity risk premium, being the basis for dividend expectations and share prices, reflects more than just investors' risk aversion and perceptions of risk. It may additionally reflect distortions in analysts' expectations.

Ex post, estimates obtained from surveys prove to contain distortions, …

An investigation using a very long history of I/B/E/S analysts' earnings forecasts for DAX companies refutes the hypothesis of undistorted consensus forecasts at the index level. This could be because analysts are slow to update their forecasts and are backward-looking in their expectations formation, or it could be due to economic shocks which affect the realisation of earnings.

… but ex ante they are important for valuations

For all that, analyst forecasts are nonetheless valuable indicators of stock market participants' expectations. The size and sign of analysts' systematic forecast errors are unknown *ex ante*.[6] Even if, in hindsight, earnings and dividend expectations prove to have been wrong, it is safe to assume that analyst forecasts influence market players' investment decisions and stock market valuations *ex ante*.

Valuation metrics for the German stock market

Charting the individual indicators

Equity risk premium, implied cost of equity and earnings yield as indicators of valuation level

The analyst estimates outlined above can be used to calculate and compare the implied cost of equity, equity risk premium and earnings yield for the DAX (see also the box on pages 20 and 21). The lower part of the chart on page 18 shows how these indicators have developed. High levels indicate that shares are cheap as measured against analyst expectations, which is frequently seen as signalling that investors are highly averse to risk. Low levels, by contrast, denote that investors are receiving little compensation for the risk of an equity investment as compared with expected earnings or dividends.

Earnings yield on similar trajectory to implied cost of equity, but subject to greater volatility

For large sections of the period under review, the implied cost of equity and the earnings yield as its special case follow a similar trajectory. Both during the 2008-09 financial crisis and at the height of the sovereign debt crisis in the euro area in 2011-12, they rose considerably, reflecting the high risk aversion prevailing at the time. However, the spikes in the earnings yield were more pronounced that those in the implied cost of equity. Moreover, the spread between them widened to several percentage

5 For a discussion on information processing in analysts' earnings forecasts, see J Hollmayr and M Kühl (2016), Learning about banks' net worth and the slow recovery after the financial crisis, mimeo.
6 For the sake of completeness, we should note that assuming that analysts do not change their behaviour, it is nonetheless possible, in principle, to determine systematic ex ante forecast errors based on a suitable estimate, if expectations are distorted.

A nominal dividend discount model

The Bundesbank, too, uses dividend discount models to assess stock market valuation levels.[1] Improved data availability means that newer models can – unlike older procedures – draw on dividend expectations and matched-maturity risk-free interest rates. One such newer model is presented below.

In the dividend discount model, the current share price P equates to the (risk-adjusted) present value of the expected dividend path $E(D_i)$

$$P = \sum_{i=1}^{\infty} \frac{E(D_i)}{(1 + r_{E,i})^i} \ .$$

If it is assumed that the implied cost of equity $r_{E,i}$ is constant across all horizons i, this present value formula can be solved numerically for the implied cost of equity r_E, which is constant across all horizons, for a given share price P and dividend path $E(D_i)$.

The dividend discount model provides the equity risk premium (erp) if matched-maturity risk-free interest rates y_i are taken into consideration in addition to dividend expectations. In the present value formula, the sum of the matched-maturity risk-free interest rate and the equity risk premium replaces the maturity-specific implied cost of equity

$$r_{E,i} = y_i + erp \ .$$

Assuming the share price P, the dividend path $E(D_i)$ and the yield curve y_i are given, the present value formula can now be solved numerically for the equity risk premium erp.

The determinants of the optimised dividend discount model are thus the dividend expectations $E(D_i)$ and the risk-free yield curve y_i.

Maturity-dependent dividend expectations and interest rates

For dividend expectations, it has been possible since 2004 to use the monthly survey results provided by I/B/E/S, a data provider which, *inter alia,* gathers data on dividend expectations for the next three calendar years. Since 2006, the data have been available on a weekly basis.

The dividend expectations for the next 12 and 24 months, $E(D_1)$ and $E(D_2)$ respectively, are interpolated from the I/B/E/S survey's calendar-year forecasts. It is then assumed that in years three and four, the dividend expected in two years' time $E(D_2)$ will grow in line with the medium-term earnings growth expectations, which are also contained in the I/B/E/S data. As of the twelfth year, the dividends grow in line with nominal potential growth.[2] For the period between the 5th and the 12th year, it is assumed that the medium-term growth rate of the dividends will converge linearly towards long-term, nominal potential growth.

For the matched-maturity risk-free interest rates y_i, the interest rates from the Bundesbank's yield curve estimate for Federal securities are used.[3]

This means that all components of the dividend discount model are specified, which allows the present value formula to be solved for the equity risk premium erp and the implied cost of equity r_E respectively.

Nominal versus real implementation

Until now, it has been general practice to calculate and analyse the real implied cost of equity using an approximation formula, and the Bundesbank's *Monthly Reports* and the European Central Bank's publications are no

1 See Deutsche Bundesbank, Macroeconomic aspects of share price developments, Monthly Report, March 2003, p 35.
2 Nominal potential growth is parameterised using the sum of the long-term consensus expectations with regard to inflation and GDP growth.
3 In order to obtain a closed form solution for the 3rd dividend level, the 12-year interest rate y_{12} is used for all years following year 12.

exception.[4] With this method, the nominal earnings expectations used in the real calculation are deflated using survey-based inflation expectations. The inflation forecasts required to perform a deflation are, however, not available on a weekly basis – unlike the I/B/E/S surveys on dividend and earnings expectations used here. It must therefore be taken into account when comparing the (new) nominal with the (old) real implied cost of equity that the newly calculated nominal metric is greater than the real value determined using the old calculation. The difference is essentially determined by the inflation expectations.

By using the nominal implied cost of equity r_E and the nominal equity risk premium erp, expectations on dividends in the near future and the payout policy are included for the first time. By contrast, in the old real calculation – based on indicated dividends – the dividend expectations are fully approximated by expectations for the medium-term rate of earnings growth. Compared with the surveys that were used in the old indicator, the dividend surveys are based on a greater number of analyst estimates, which means that the new indicators benefit from a more robust database. Furthermore, by integrating the term structure, it is now possible, for the first time, to take account of the effects of a twist in the yield curve. In future, the Bundesbank will therefore use the nominal implied cost of equity r_E and the equity risk premium erp when reporting in its *Monthly Reports*.

4 Examples of an implementation of the real calculation can be found in: ECB, Recent equity price developments in the euro area and the United States, Economic Bulletin 4/2015, Box 2, pp 34-38, as well as Deutsche Bundesbank (2003), op cit.

points during the above-mentioned periods of high risk aversion.

Equity risk premium and implied cost of equity converge during the low-interest-rate phase

The DAX's implied cost of equity and equity risk premium have converged continuously since 2014. This reflects the fact that interest rates on German government bonds have fallen overall, in part as a result of the Eurosystem's monetary policy measures. While the implied cost of equity for the DAX was, at 7.9%, ½ percentage point below its ten-year average at the end of March 2016, the drop in interest rates caused a significant shift in the valuations of shares as compared to low-risk bonds. At 7.5%, the equity risk premium was almost 2 percentage points above its ten-year average.

Determinants of dividend discount model metrics must be verified

The dividend discount model is used to condense conditions in the corporate sector and the macroeconomic environment into a single metric. Given that the survey data on dividends inputted into the model may be distorted, it is important to verify these figures against other data. It makes sense to use survey-based expectations on sales growth, profitability and payout policy to check the equity risk premium and the implied cost of equity for plausibility. In addition, the survey-based metrics from the dividend discount model can be compared with risk indicators that are independent of survey forecasts.

Sales revenue growth, profitability and payout policy

Earnings and dividends at the end of the value chain

Earnings and dividends are found at the end of a long corporate value chain. Their dynamics are dictated by sales revenue growth, cost developments and the company's chosen payout policy. Accounting options and changes to the payout policy allow businesses to influence their earnings and dividends.

Surveys of earnings and dividend expectations were joined, in 2004, by surveys about ex-

DAX companies' profit margin and payout policy

%, weekly data

Sources: I/B/E/S (Thomson Reuters Datastream) and Bundesbank calculations. **1** Profit as a percentage of sales revenue for DAX companies. **2** Realisation refers to the past 12 months, expectations to the next 12 months. **3** Dividend payments as a percentage of profit.

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Leverage effect of fixed costs on earnings

pected sales revenue, allowing the analyses of metrics from the dividend discount model to now be supplemented with a stylised analysis of the profit and loss account based on expectations data. In the past few years, the profit margin – profit as a percentage of sales revenue – of DAX enterprises has stood at around 5%.[7] It has fluctuated considerably with the economic cycle, as a result of which the leverage effect of interest payments (financial leverage) and especially of operating fixed costs (operating leverage) has an impact on profit. It is also interesting that analysts mostly predict an increase in the profit margin as the forecast horizon lengthens. Given the short history, however, it remains to be seen whether this reflects a systematic overestimation or whether analysts repeatedly had false expectations that the economy would pick up.

Dividend smoothing cushions profit volatility

The payout ratio is the percentage of annual profit distributed to the shareholders as a dividend. In normal cyclical phases, DAX companies pay out around 40% of their annual profit on average, while in crisis periods this figure can rise to almost 60%. Companies tend to avoid passing on slumps in profits they see as temporary to their shareholders (in full) by reducing dividends, but instead smooth out the dividend payment, which makes the payout ratio higher in crisis periods. This behaviour is common for realised dividends, and it is also reflected in the data on expectations, with the fluctuations in the payout ratio becoming smaller as the horizon increases.[8]

Impact of payout policy and fixed costs on earnings yield and implied cost of equity …

The higher volatility of earnings compared to dividends is also demonstrated by the fact that the earnings yield rose more strongly during the economic crisis from 2008 to early 2009 than the implied cost of equity based on dividend expectations. Conversely, in the following months the reduction in the payout ratio counteracted the positive effect of revenue growth and the profit margin, bringing the earnings yield and the implied cost of equity closer together again.

… should be heeded particularly in crisis periods

Dividend smoothing can only temporarily counteract fluctuations in sales revenue and profit margins. If a crisis turns out to be more persistent that originally expected, the change in payout policy necessitated by this would be another potential setback for the stock market. This explains why it is so important to analyse dividend components in crisis phases.

7 The profit margin derived from I/B/E/S figures is higher than the margins of non-financial corporations determined from annual accounts or consolidated financial statements. The main reason for this is the inclusion of financial corporations in the I/B/E/S dataset. Financial corporations generally have a higher profit margin than non-financial corporations owing to the special definition of sales revenue. See Deutsche Bundesbank, German enterprises' profitability and financing in 2014, Monthly Report, December 2015, pp 30-46.

8 Dividend smoothing is a widespread global phenomenon among companies, and it is examined on the basis of realised data for Germany by C Andres, M Doumet, E Fernau and E Theissen (2015) in The Lintner model revisited: Dividends versus total payouts, Journal of Banking and Finance 55, pp 56-69.

Equity-specific and general risk

Comparison of indicators of dividend discount model with survey-independent risk indicators

The indicators presented in this article – particularly the equity risk premium derived here and the implied cost of equity – measure stock prices in the context of analyst expectations. However, the results remain methodologically dependent on the quality of the survey data. It is therefore expedient to compare the equity risk premium of the dividend discount model with risk indicators that are not dependent on surveys. The theoretical basis for this notion is that microfounded valuation models, which explicitly model investors' risk appetite, suggest that the risk indicators of different markets do not move independently of one another (see the box on pages 24 to 26). If metrics captured using different methodologies were seen to move in tandem, the survey-based equity risk premium could then serve not only as a gauge for stock valuation, but also as a general measure of risk. It would thus also contain expectations about the overall economic setting in which the companies operate. The following section therefore compares the equity risk premium and implied cost of equity with the yield spread of corporate bonds and a measure of volatility.

Yield spreads of corporate bonds …

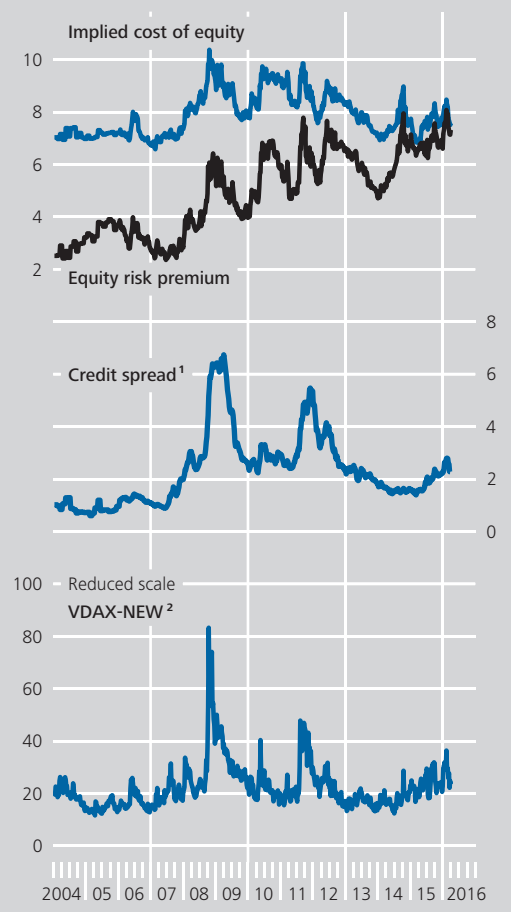
The corporate bond yield spread over matched-maturity safe bonds contains not only a component that compensates for expected default, but also compensation for the willingness to assume the risk of default, which is related to investors' risk aversion. This "credit spread", as it is known, can thus be interpreted as a bond risk premium (risk premium on debt). The credit spread should be highly correlated with the equity risk premium because changes in default risk impact on the value of both equity and debt.

… and volatility measures show similar development to indicators of the dividend discount model …

Volatility indices such as the VDAX-NEW can also be used. The VDAX-NEW represents uncertainty about the expected performance of the DAX index. Being linked to options, it thus constitutes a measure of the value of risk weighted by preferences. The adjacent chart depicts the two aforementioned survey-independent risk indicators, showing that the indicators followed similar paths in the financial crisis of 2008-09 and during the European sovereign debt crisis of 2011-12.

Valuation indicators of the dividend discount model and external risk indicators

% or percentage points, weekly data



Sources: I/B/E/S (Thomson Reuters Datastream), Consensus Economics and Bundesbank calculations. **1** Yield spread of seven to ten-year BBB-rated corporate bonds over Federal bonds with comparable residual maturities according to iBoxx. **2** Volatility index based on DAX options.

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… and empirically significant comovement

A regression analysis confirms this comovement (see the table on page 27).[9] It reveals that the movement of the credit spread of corporate bonds is significantly similar to both the equity risk premium and the implied cost of equity. A 10 basis point increase in the credit

9 Since the variables are integrated, an approximation is carried out using differentials.

Microfoundations of the equity risk premium

Assets differ according to how safe their returns are. Savers, for instance, will expect risky assets such as equities to generate a higher return than practically risk-free investments like German Federal bonds. This is also known as the expected excess return over the risk-free rate. Identifying this return – and not just for a single security but for the market as a whole – can be done with the aid of what are known as capital asset pricing models. One such widely used model is the consumption capital asset pricing model (CCAPM) developed by Lucas (1978), which shows the prices of asset holdings in relation to the consumption which a given security can finance in different environments.[1] Thus, the Lucas model includes a consumption-based microfoundation for excess returns. As a special case – one that does not explicitly model the consumption habits of investors – this model also incorporates the classic capital asset pricing model (CAPM).

The Lucas model is based on a neoclassical growth model that establishes a connection between two temporally distinct "goods" – consumption today and consumption in some future period. The relative price of these two types of consumption depends on the extent to which consumers are willing to shift their consumption into a future period and on the ability of producers to provide consumer goods tomorrow rather than today. Taking account of the extent to which consumers are willing to shift consumption into the (uncertain) future is a notion found not only in business cycle models but also in approaches used to model income flows from financial assets.

Intertemporal models like these are built around the idea that while purchasing a financial asset embodies the right to consume tomorrow, albeit in an uncertain amount, it also means sacrificing consumption today in the amount of the purchase price. A major aspect in such models is the fact that the future payoff on the financial asset, which in the case of an equity share consists of its future price P_{t+1} plus dividend D_{t+1}, depends on a currently uncertain future state. Thus, a given future payoff in "good times" is worth less, relatively speaking, than it is in "bad times", when the amount of consumption is lower and the additional payoff is therefore particularly welcome. Following this line of thinking, an equity share with an income stream that is highly correlated with the general amount of consumption is of little value by comparison, and will need to offer a high expected return to be worth holding.

Microeconomists model this state dependency in utility function $U(c_t)$, where the amount of consumption c_t stands for the state of the economy as a whole. In such a utility function, each additional unit of consumption usually has a diminishing marginal utility – that is, growing consumption raises utility by a smaller and smaller amount. Maximum utility is achieved in the two periods in question when the loss in utility resulting from sacrificing consumption today (in order to purchase an equity share) is equal to the utility gains made possible by the additional consumption in the future period. This is a concept frequently referred to as "consumption smoothing".

These are the theoretical foundations upon which the CCAPM is based. Thus, the price of a security in a market equilibrium is equal to the expected value of the future payoff which is weighted by the time preference rate θ and the ratio of marginal utilities $U'(.)$.[2]

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1 See R E Lucas (1978), Asset prices in an exchange economy, Econometrica 46, pp 1429-45.
2 See R Mehra and E C Prescott (2008), The equity premium: ABCs, in R Mehra (ed), Handbook of the equity risk premium, pp 16-17.

$$P_{i,t} = E_t\left(e^{-\theta} \cdot \frac{U'(c_{t+1})}{U'(c_t)} \cdot (P_{i,t+1} + D_{i,t+1})\right).$$

This price equation can now be rearranged to show that the investor expects to receive a risk premium (on top of the risk-free rate) for sacrificing consumption today because consumption smoothing is uncertain when an equity share is purchased. This uncertainty can be captured using the covariance cov_t of the future equity return with the marginal utility of higher consumption. If we define the return on a single equity share as $R_{i,t+1} = (P_{i,t+1} + D_{i,t+1})/P_{i,t} - 1$, the above price equation can be rearranged to show the risk premium of a single equity share $E_t(R_{i,t+1}) - r_{f,t}$ over and above the risk-free rate $r_{f,t}$.[3]

$$E_t(R_{i,t+1}) - r_{f,t} = \frac{cov_t\big(R_{i,t+1}, U'(c_{t+1})\big)}{E_t\big(U'(c_{t+1})\big)}.$$

The less covariate the equity return and the amount of consumption, the lower the equity risk premium which investors expect to receive. Hence, the equity risk premium will be low when the income stream generated by the equity share readily serves the investor's intention to smooth his or her consumption.

The classic CAPM is a variation on this consumption-based CAPM. What connects the two models is the assumption that the valuation of the financial market is conducive to modelling the state of the economy, and thus the given amount of consumption. If the marginal utility of consumption $U'(c_{t+1})$ is perfectly correlated with market performance, the outcome is the widely-known CAPM formula.[4]

$$E_t(R_{i,t+1}) - r_{f,t} = \beta_i\big(E_t(R_{M,t+1}) - r_{f,t}\big).$$

Hence, the expected risk premium of a single security $E_t(R_{i,t+1}) - r_{f,t}$ is a linear function of the expected market risk premium $E_t(R_{M,t+1}) - r_{f,t}$. The correlation between the two is determined by the β_i which, in formal terms, represents the quotients of covariance $cov\,(R_{M,t+1}, R_{i,t+1})$ and variance of the market return.[5] After rearranging, the risk premium of a single equity share can be presented as follows.

$$E_t(R_{i,t+1}) - r_{f,t} = \sigma(R_{i,t+1}) \cdot corr(R_{M,t+1}, R_{i,t+1}) \cdot \frac{E_t(R_{M,t+1}) - r_{f,t}}{\sigma(R_{M,t+1})}.$$

This makes plain that fluctuations in the return on a single security ($R_{i,t+1}$) will only ever have a bearing on that security's risk premium if those fluctuations are systematically correlated – ie they have a correlation different than zero $corr\,(R_{M,t+1}, R_{i,t+1})$ – to the market as a whole. Idiosyncratic fluctuations in security returns, on the other hand, even each other out in a large portfolio that is not correlated to the entire market. This diversification of risk implies that security-specific fluctuations have no bearing on the valuation of a single equity share. At the same time, non-diversifiable, systematic fluctuations come to the fore in the market price of risk $\frac{E_t(R_{M,t+1}) - r_{f,t}}{\sigma(R_{M,t+1})}$, which denotes how much excess return the investor is expecting to receive for taking on one unit of systematic risk.

Empirically, the implications of the CAPM for the equity market in this original form have frequently been rejected, however. For one thing, empirical testing revealed that there are other variables, alongside the market risk premium of the equity market, which are systematically correlated to the equity risk premium, such as the size of a corporation, book value

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3 To simplify the notation used, the dividend discount model discussed in the main article denotes the equity return expected in the future period as $r_i = E_t(R_{i,t+1})$, where the financial asset being valued i is a share (equity).

4 See K Cuthbertson and D Nitzsche (2004), Quantitative Financial Economics, 2nd edition, p 310. The assumption that market and marginal utility are perfectly correlated implies that the functional form of the utility function needs to meet specific expectations.

5 Even if empirical tests of the CAPM are normally confined to the equity market, the market portfolio generally encompasses all tradable and non-tradable assets.

or past performance.[6] For another, in a postulation originally articulated in Mehra and Prescott (1985), it became evident that the equity risk premiums derived theoretically in the CCAPM under plausible risk aversion parameters are considerably smaller than the equity risk premiums estimated empirically from market data.[7] This divergence between theoretical and empirical findings has become known as the equity premium puzzle. Despite numerous attempts to solve this puzzle, not even later papers have managed to deliver a satisfactory explanation.[8]

But one point upon which all the subsequent research agrees is that only systematic fluctuations by a security with the state of the economy as a whole determine its risk premium. Moreover, this intuitive feature of capital asset pricing models is not confined to the equity market – it applies to any securities market and delivers a theoretical rationale for the covariance of risk indicators for various markets. What this means for the economic interpretation of an equity risk premium derived from a dividend discount model is that a certain degree of correlation – with the yield spreads of corporate bonds, say – is generally to be expected, the implication being that deviations in risk measures could be interpreted as an indication of misvaluation.

6 See E F Fama and K R French (1993), Common risk factors in the returns on stocks and bonds, Journal of Financial Economics 33, pp 3-56; and M M Carhart (1997), On persistence in mutual fund performance, The Journal of Finance 52, pp 57-82.
7 See R Mehra and E C Prescott (1985), The equity premium – a puzzle, Journal of Monetary Economics 15, pp 145-161.
8 See, for example, R Mehra and E C Prescott (2003), The equity premium in retrospect, in G M Constantinides, M Harris and R Stulz (eds), Handbook of the Economics of Finance, pp 887-936.

spread is accompanied by an increase of 7 basis points in the equity risk premium and of 5 basis points in the implied cost of equity. The empirical relationship between the VDAX-NEW and the equity risk premium is also positive, although the parameter value in a univariate estimate is less strongly supported (at a confidence level of no more than 10%). In a joint estimate with the credit spread, the significance even disappears, which shows – as was presumed – that the credit spread and the uncertainty reflected in the VDAX-NEW are not independent of one another. Overall, the two survey-independent risk indicators display covariance of roughly one-sixth with the changes in the equity risk premium and those in the implied cost of equity.

Deviations in indicators give cause for caution

In spite of the indicators' fairly close correlation over the entire observation period, there are also periods in which the measures deviate significantly from one another. One example is the strong increase in both the equity risk premium and the cost of equity in the second half of 2010, which saw no response by either of the other two measures analysed here. This was due to growing medium-term earnings expectations in that period, which meant that the price level at the time in the dividend discount model appeared favourable, and not to an isolated increase in risk aversion, which would also have been reflected in other market-based indicators.

Recent divergence between equity risk premium and other risk indicators

Another divergence has been discernible since summer 2014, from which point the implied equity risk premium has been rising, but not the other risk indicators. This could potentially be a consequence of the Eurosystem's accommodative monetary policy, which is likely to have had a dampening overall effect on the yields and risk premiums of government bonds. This also raises the question as to the connection between stock market performance and the interest rate level.

The search for yield in the stock market and flight to safe havens in the low-interest-rate setting

Dividend discount model suited to exploring the connection between equities and bonds

One factor in the debate about the current low-interest-rate environment is the concern that investors on the search for yield in the stock markets may enter into incautious exposures. Alternatively to the search for yield, investment behaviour could also be determined by the search for safe investments (eg safe haven flows), for example. Analysing developments in the yield on Federal bonds and the equity risk premium or the implied cost of equity enables an assessment to be made of which of the two types of investor behaviour has the upper hand. In addition to this, the dividend discount model can be used to aid what is known as a counterfactual analysis, through which the influence of an individual factor – such as the effect of interest rates – on the price movement can be extracted.[10]

Search for yield and search for safe havens move in phases

On the whole, the yield level of ten-year Federal bonds has fallen distinctly in recent years; at the end of March 2016 it was just 0.1% (see the chart on page 28). Measured against the DAX, this sent the equity risk premium to its current high level, whereas no clear trend is discernible for the implied cost of equity. However, there were also spells in which the two indicators of the dividend discount model moved in the same direction, from which phases of an increased search for yield and phases of safe haven inflows can be identified.

Price rise between mid-2012 and mid-2013 reflects diminishing equity risk premium …

The yield level of long-term Federal bonds barely changed between mid-2012 and mid-2013. At the time, interest rates were already very low by historical standards, which made for fairly unattractive investment conditions. But at the same time, both the implied cost of equity and the equity risk premium decreased, in a reflection of a heightened stock market valuation. A situation such as this, in which risk indicators decline concurrently, points to an intensified search for yield among investors. The shrinking equity risk premium in this period also goes the furthest towards explaining share price developments, while the revised dividend expectations and the risk-free interest rate have little influence on prices (see the chart on page 29). What is more, the decrease in the equity risk premium in this period reveals subsiding risk aversion among investors, which is likely to be related in part to the easing of the sovereign debt crisis.

… consistent with investors' subsiding risk aversion and intensified search for yield

The second half of 2013 saw Federal bond yields briefly make up a little ground. This phase gave way, at the beginning of 2014, to a long

Correlation between valuation indicators of the dividend discount model and external risk indicators*

Independent variables	Dependent variable: Equity risk premium (erp)	Dependent variable: Implied cost of equity (r_E)
Constant	0.006 (0.880)	0.000 (0.062)
Credit spread	0.721*** (9.876)	0.523*** (9.600)
VDAX-NEW	0.008 (1.084)	0.006 (1.026)
Coefficient of determination (%)	18.34	15.99

Sources: I/B/E/S (Thomson Reuters Datastream), Consensus Economics and Bundesbank calculations. * Regressions in differences using the dependent variables equity risk premium (erp) and implied cost of equity (r_E). Absolute t-values in brackets. The credit spread equals the yield spread of seven to ten-year BBB-rated corporate bonds over Federal bonds with comparable residual maturities according to iBoxx; VDAX-NEW is the volatility index based on DAX options. ***, ** and * indicate values significantly different from zero at the confidence levels of 1%, 5% and 10%, respectively.

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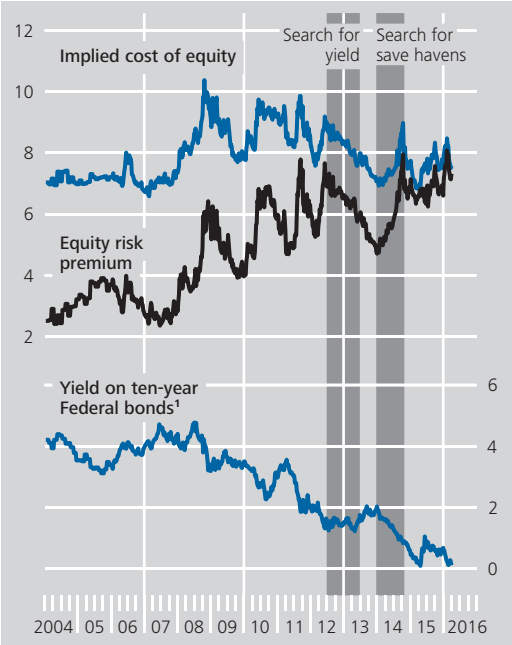
10 In order to isolate the effect of interest rates, for instance, all input factors except for the interest rate are kept constant at a given point in time and the model price of the index is then calculated under these conditions. The contribution of interest rates to the observed price change can then be extracted from this model price. If this procedure is performed for all input factors, the observed yield can be broken down into its driving forces. Since this is a linear approximation, the sum of the individual factors' contributions to the price change need not equal the realised price change.

Valuation indicators of the dividend discount model and yield on ten-year Federal bonds

% or percentage points, weekly data



Sources: I/B/E/S (Thomson Reuters Datastream), Consensus Economics and Bundesbank calculations. **1** Calculated from the yield curve of listed Federal securities.

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Falling interest rate and rising equity risk premium between January and October 2014

and persistent drop in interest rates, which coincided with a rise in the implied cost of equity and the equity risk premium up until October 2014. This period is consistent with safe haven flows, which are characterised by investors turning their backs on risky investments and switching to safe instruments.

Expected loosening of monetary policy reduces implied cost of equity between October 2014 and April 2015

In the period between October 2014 and April 2015, the expectation that the Eurosystem would take expansionary monetary policy measures increasingly gained traction. Yields on Federal bonds also fell during this spell. By contrast, the risk indicators saw diverging developments. While the implied cost of equity fell back to a low level, the equity risk premium followed only part of the way, moving at a high level until recently. In times like these, it is difficult to clearly identify investors' motives. What can be concluded, however, is that in phases of strongly shrinking yields, a higher valuation level in the stock market does not generally go hand in hand with more incautious investor behaviour. The breakdown of DAX movements for the period since the end of 2013 (see the chart on page 29) shows that the opposite is true: the price-increasing effect of the drop in interest rates was dampened overall by the increase in the equity risk premium.

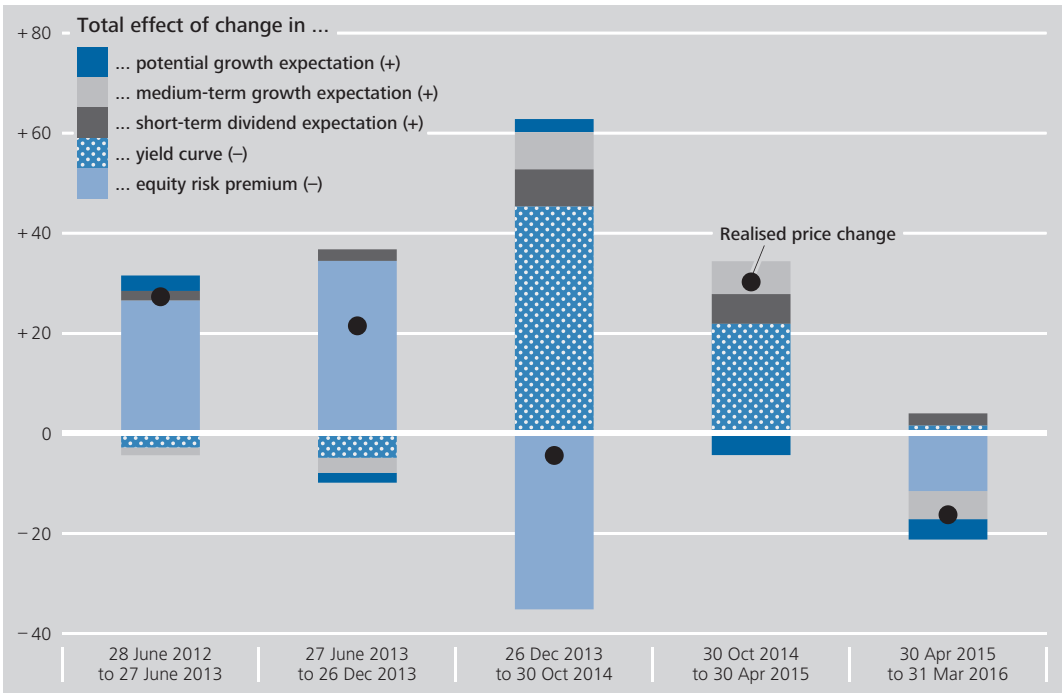
Break caused by spasmodic yield surge in April 2015

Following a spasmodic rise which peaked at almost 1% ("Bund tantrum"), the yield on ten-year Federal bonds has been back on a downward path since mid-May 2015. This period saw the equity risk premium rise significantly more strongly on balance than the implied cost of equity. The countervailing movement of interest rates and risk indicators in the stock market contradicts the hypothesis that investors are entering into excessive risk in the stock market on account of the falling interest rate level.

Methodological notes on the interpretability of the equity risk premium

Measured in terms of the implied equity risk premium, the equity valuation level may seem quite low at present. However, since the equity risk premium values equities relative to safe government bonds, it is impossible to say whether the stock markets are undervalued or the government bond markets overvalued. The divergence may, in fact, be representative of a general methodological problem surrounding the use of interest rates in dividend discount models: future payments in the dividend discount model are discounted at long-term interest rates which contain a premium for maturity risk (term premium), instead of at expected future short-term interest rates, as the theoretical model envisages. Forward guidance and asset purchase programmes aim to influence the path of monetary policy. This ought to also reduce uncertainty over the future monetary policy path and hence the term premium as well, with the result that current long-term interest rates should contain a smaller term premium than in the past. The equity risk premium is particularly high as a result. The current level of the equity risk premium as a relative valuation measure for equities compared with government bonds is therefore conditional on the present low interest rate level.

Role of explanatory factors of the dividend discount model in DAX price change*



Sources: I/B/E/S (Thomson Reuters Datastream), Consensus Economics and Bundesbank calculations. * Change in DAX performance index. A positive (negative) column represents a price-increasing (price-decreasing) contribution of the explanatory factors during the observation periods. Sensitivities are given in brackets, showing whether an explanatory factor's increase raises (+) or lowers (–) the price. The realised price change need not match the column total as the model is based on a linear approximation.
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Conclusion

Taking the dividend discount model a step further

The dividend discount model can be extended to include interest rates and expectations data derived from analyst estimates, with each element being maturity-specific. The implied cost of equity and equity risk premiums derived in this way are more precise than the indicators calculated using the methods normally employed. Moreover, they can be tested for robustness against additional corporate figures collected from surveys.

Implied cost of equity and equity risk premium as measures of macroeconomic health

As a measure of market players' risk perception, these indicators are not just a gauge for stock market valuations, but also general risk indicators which also reflect expectations about the macroeconomic setting. Using a model-based breakdown of stock market developments based on the dividend discount model, it is possible to separate the effects of the individual determinants and better interpret the overall dynamic of the stock markets from an economic perspective.

Dividend discount model as part of a broad indicator-based approach

What must also be concluded, however, is that the dividend discount model alone cannot say for sure whether a valuation level is appropriate or not. As a case in point, the dividend discount model does not flag an overvaluation when expectations about future dividends are excessively high. Consequently, the level and development of the equity risk premium and of the implied cost of equity should be checked for consistency with the paths followed by other risk indicators.