Determination of the risk premium (comment on the expert opinion of Frontier Economics)

Expert opinion on behalf of Netze BW

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Summary

On 14 July 2021, the Federal Network Agency published the identical draft for the determination of the regulated equity interest rate for electricity and gas network operators. According to this draft, the equity interest rate to be applied to new installations is at least 4.59%. [1]This interest rate consists of a basic interest rate (0.74%), a surcharge to cover network operation-specific entrepreneurial risks (3%) and a tax factor (multiplier of 1.226). The Federal Network Agency is also consulting on a possible adjustment of the risk surcharge by up to 25 basis points.

The Federal Network Agency was supported by Frontier Economics and Professors Randl and Zechner (hereinafter abbreviated to Frontier Economics) for the determination of the surcharge to cover network operation-specific entrepreneurial risks.[2] We have been asked by Netze BW to review the expert report submitted by Frontier Economics. The focus of our review is the derivation of the correction requirement for the market risk premium as a component of the risk premium, as well as the applicability of the global CAPM and its implementation and the use of historical data to derive the market risk premium.

Frontier Economics' approach to identifying the need for correction

Frontier Economics derive the market risk premium on the basis of the Capital Asset Pricing Model (CAPM)[3]. Frontier Economics assume that capital markets are internationally integrated, so that an investor can be assumed to invest in a global equity portfolio. Frontier Economics assume that the market risk premium is constant over the long term and can be [4]derived from a comparison of realised equity and bond returns over the last 121 years based on the Dimson, Marsh and Staunton (DMS) data set.

[1] Cf. Bundesnetzagentur (2021), "Procedural initiation and consultation of the draft decision regarding the determination of equity interest rates pursuant to section 7(6) StromNEV"; Bundesnetzagentur (2021), "Procedural initiation and consultation of the draft decision regarding the determination of equity interest rates pursuant to section 7(6) GasNEV".

[2] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July.

[3] See Sharpe, W. (1964), "Capital asset prices: A theory of market equilibrium under conditions of risk", *The Journal of Finance*, **19**:3, pp. 425-442; Lintner, J. (1965), "Security prices, risk, and maximal gains from diversification", *The Journal of Finance*, **20**:4, pp. 587-615; Mossin, J. (1965), "Equilibrium in a capital asset market", *Econometrica*, **34**:4, pp. 768-783.

[4] See Dimson, E., Marsh P.R. and Staunton, M. (2020), 'Credit Suisse Global Investment Returns Yearbook 2020.

Frontier Economics recognise that the bonds used to determine the risk-free base rate under Section 7 StromNEV / GasNEV (current yields of German issuers) and the market risk premium (realised yields of a portfolio consisting of long-term bonds of different countries) differ and determine a possible surcharge of 0 to 25 basis points to address these differences. Frontier Economics determine this adjustment requirement based on a 10-year average of (forward) yield differentials. In doing so, Frontier Economics considers a lower bound of zero to be warranted because the observed difference in yields is not pronounced in individual years. The upper limit of the surcharge is 25 basis points in the view of Frontier Economics.

No lower limit of the need for zero correction

We consider an analysis period of 10 years for determining a need for correction for the market risk premium to be already very short, as the market risk premium is derived on the basis of data from the last 121 years. However, the analysis period of 10 years is at least consistent with the rules for determining the risk-free base rate. It is not methodologically justifiable to consider trend deviations of individual years as a lower limit for the need to correct a long-term mean. The lower limit of the need for correction determined by Frontier Economics should therefore not be taken into account when determining the equity interest rate.

Correction for runtime differences is too small

We agree with Frontier Economics that the market risk premium needs to be adjusted upwards to take into account the differences in remaining maturities between the bonds in the base rate according to § 7 StromNEV /GasNEV and the bonds in the DMS world bond portfolio. In addition, differences in the composition of the portfolios (e.g. inclusion of corporate bonds in the StromNEV/GasNEV index) must be taken into account. The bonds in the base rate pursuant to Section 7 StromNEV /GasNEV have an average remaining term of approx. 6 to 7 years, while the DMS bonds used to determine the market risk premium currently have an average remaining term of at least 16 years.

Frontier Economics determine the correction requirement of 10 basis points for both differences jointly by comparing the current yields of German issuers with the yield of a German zero-coupon government bond with a remaining maturity of ten years. We do not consider this correction sufficient, as it does not

adequately account for the maturity difference between the current yields and the DMS bonds. Instead, we propose to base the correction on government bonds, including coupon payments, with a remaining maturity of 16 years, as this bond is more comparable to the structure of the DMS bond portfolio. This adjustment to Frontier Economics' approach increases the correction required to the market risk premium for maturity mismatches to 54 basis points.

Correction of the adjustment for the availability premium of Frontier Economics is too low

We agree with Frontier Economics that German government bonds have a special international position and an availability premium (convenience yields). We note that the analysis conducted by Frontier Economics did not attempt to quantify the availability premium in German government bonds. [5]Instead, Frontier Economics quantified the yield differential (15 basis points) between Germany and other DMS Eurozone Aaa government bonds. We agree that the yield differential between German government bonds and government bonds of other countries needs to be accounted for in the DMS bond portfolio. Accordingly, we first correct Frontier Economics' analysis of the yield differential between Germany and Aaa bonds in the euro area, and then extend the analysis to correct for the yield differential between Germany and non-Aaa bonds in the DMS bond portfolio (see next subsection).

In deriving this correction factor (i.e. the Aaa yield differential in government bonds, which Frontier Economics has termed a "convenience yield""), Frontier Economics compare the yields of German government bonds with the average yields of Aaa government bonds of the euro countries. In doing so, Frontier Economics fails to recognize that average euro area Aaa government bond yields are primarily influenced by German government bonds and therefore identifies an undercorrection of only 15 basis points. We correct for this error by comparing German and Dutch government bond yields (the Netherlands is currently the only DMS euro country with an Aaa rating). In addition, we apply the method of Jiang et al. (2020) to estimate the yield differential for Germany relative to all euro-denominated government bonds in the DMS bond portfolio as a measure of differences in the availability premium. In this estimation, the

[5] Oxera has published analyses based on academic and empirical evidence showing an availability premium for sovereign bonds of around 50-100 basis points. See, for example, Oxera (2020), "Are sovereign yields the risk-free rate for the CAPM?", prepared for the Energy Networks Association, 20 May.

observed yield differences are adjusted for differences in default risk. [6]This leads to an increase in this adjustment factor, which Frontier Economics put at 15 basis points for the availability premium. We consider it necessary to correct this adjustment to 25 basis points.

Lack of correction for default risk differences

German government bonds differ from DMS bonds in terms of their creditworthiness. While German government bonds have an Aaa rating, the rating agencies currently assume a higher default risk for at least 13 countries. [7]Frontier Economics have not yet applied a correction for these default risk differentials. We consider a correction requirement of 37 basis points on the basis of credit default swap spreads to correct for different default risks to be imperative.

Global CAPM is not applicable and is improperly implemented

Notwithstanding the undoubted need to correct the market risk premium for differences in bond characteristics, we do not consider Frontier Economics' basic approach to determining the market risk premium to be appropriate. Frontier Economics argue that capital markets would be integrated currently and in the future, but model the market risk premium based on historical data. Capital markets cannot be considered integrated at all points in time in the past. This ignores exchange rate risks by stating that these risks would play no role in determining the market risk premium, which is demonstrably incorrect. In addition, the global CAPM is not implemented appropriately, which is only partially remedied by the corrections made to the market risk premium.

DMS data set carries a high risk of underestimation

The DMS dataset used by Frontier Economics carries a high risk of underestimating the market risk premium. The expected future excess return of stocks over bonds is approximated by past realized return differentials. When interest rates fall in the long run, bond prices rise and realized bond yields are

[6] See Jiang, Z., Lustig, H. N.. , Van Nieuwerburgh, S. and Xiaolan, M. Z. (2020), "Bond Convenience Yields in the Eurozone Currency Union", 22 December, https://ssrn.com/abstract=3797321 or http://dx.doi.org/10.2139/ssrn.3797321.

[7] To determine the adjustments based on different default risks, we conduct an analysis with reference to the current and 10-year historical average differences in yields and CDS premia. We rely on this period to be consistent with the Frontier Economics approach and adjust the analysis directly. We also note that an analysis period of 10 years is consistent with the averaging period used to calculate the risk-free base rate Section 7 StromNEV /GasNEV. Notwithstanding this, we theorized in Chapter 2 that Frontier Economics neglected to consider the entire 121-year DMS period.

systematically higher than contemporaneous forward-looking current yields ("yield to maturity"), leading to a reduction in the DMS market risk premium.[8] However, Frontier Economics claim that an analogous effect would also be expected for equity returns, and that the market risk premium would therefore not be underestimated. Frontier Economics present no evidence to support this claim. From financial market theory, it is expected that the effect of an interest rate cut on the price development of stocks and bonds (also called duration) depends on different factors. Empirical studies from the financial market literature show that the duration of equities has been significantly lower than the duration of government bonds, especially since the late 1990s. [9]There is therefore a high risk that the market risk premium is underestimated due to high price gains of bonds. Moreover, there is empirical evidence that the DMS dataset systematically underestimates the relevance of high-yielding equity markets (especially the US), particularly in the first half of the 20th century. As a result, the historical returns of the world equity portfolio, and hence the world market risk premium, are underestimated.

Overall conclusion

In the overall view of all results, we consider a correction of the market risk premium of at least 116 basis points to be imperative in order to make at least the bonds used to determine the base rate and the market risk premium comparable. However, this does not solve all the problems of Frontier Economics' approach. We therefore consider it advisable to take other methods into account as a supplement when determining the regulated equity capital interest rate in order to ensure an appropriate, competitive and risk-adjusted return on the equity capital employed.

[8] When market interest rates fall, bond prices rise, leading to falling bond yields. A risk-free rate based on forward-looking current yields will be lower than historical realized bond yields when interest rates fall. Therefore, a market risk premium determined according to the DMS dataset and based on historical realised bond yields will be lower than a market risk premium estimated by reference to forward-looking current yields.

[9] See, for example, Reilly, F.K., Wright, D.J. and Johnson, R.R. (2007), "Analysis of the Interest Rate Sensitivity of Common Stocks", *The Journal of Portfolio Management*, **33**:3, pp. 85-107.

1 Introduction

On 14 July 2021, the Federal Network Agency published the draft for the determination of the regulated equity interest rate for electricity and gas network operators. According to this draft, the equity capital interest rate to be applied to new installations is at least 4.59% and consists of a basic interest rate (0.74%), a surcharge to cover network operation-specific entrepreneurial risks (min. 3%) and a tax factor to present the interest rate as a pre-tax interest rate (multiplier of 1.226). The Federal Network Agency also leaves open the possibility of adjusting the risk premium by up to 25 basis points. [10]

The applicable base rate is to be set by regulation at a ten-year average of the current yields of fixed-interest securities of domestic issuers. [11]The Federal Network Agency derives the risk premium on the basis of the Capital Asset Pricing Model (CAPM)[12], whereby the regulatory base rate is interpreted as a risk-free interest rate in the course of the CAPM. According to this model, the risk premium is made up of two components: the market risk premium, i.e. the expected return on a risky market portfolio less the risk-free interest rate (min. 3.7%), and the beta factor (0.81), i.e. the degree of systematic risk of an investment measured against the market portfolio.

In order to determine the risk premium, the Bundesnetzagentur sought the expert support of Frontier Economics and Professors Randl and Zechner (referred to below as Frontier Economics). In [13]deriving the market risk premium, Frontier Economics assume the following premises.

- The capital markets are sufficiently integrated internationally so that an investor can be assumed to invest in a global equity portfolio.
- The return on a risk-free investment can be mapped on the basis of returns on a global portfolio of government bonds from different countries.

[10] Cf. Bundesnetzagentur (2021), draft decision regarding the setting of equity interest rates under section 7(6) Strom-/GasNEV.

[11] Cf. Bundesnetzagentur (2021), draft decision regarding the setting of equity interest rates under section 7(6) Strom-/GasNEV.

[12] See Sharpe, W. (1964), "Capital asset prices: A theory of market equilibrium under conditions of risk", *Journal of Finance*, **19**, pp. 425-444; Lintner, J. (1965), "Security prices, risk and maximal gains from diversification", *Journal of Finance*, **20**, pp. 587-615; Mossin, J. (1965), "Equilibrium in a capital asset market", *Econometrica*, **35**, pp. 768-783.

[13] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July.

- Currency risks play a subordinate role in the calculation of the market risk premium and do not have to be taken into account.
- The market risk premium is constant over the long run and can be [14]derived from a comparison of realized stock and bond returns over the past 121 years based on the Dimson, Marsh, and Staunton (DMS) data set.

Frontier Economics takes into account possible differences between the characteristics of the bonds used to determine the risk-free base rate and the DMS bond yields used to determine the market risk premium, in particular differences in the maturity premium and differences in the convenience yield, and quantifies these differences to be between 0 and 25 basis points. [15]

Netze BW has asked us to review the expert report submitted by Frontier Economics. In particular, we are asked to examine whether the adjustment of the market risk premium determined by Frontier Economics is sufficient to adequately address the differences between the risk-free base rate and the DMS bond yields. In addition, we were asked to comment on Frontier Economics' statements regarding the applicability of the global CAPM and its implementation, as well as the use of the DMS dataset.

Our expert report is structured as follows.

- In Section 2we describe Frontier Economics' approach to deriving the correction required for the market risk premium and derive what we believe is an appropriate correction.
- Chapter 3describes the weaknesses of the global CAPM used by Frontier Economics and the improper implementation of this model.
- Chapter 4describes the weaknesses of the data used by Frontier Economics to derive the market risk premium.
- Chapter 5contains an overall conclusion.

[14] See Dimson, E., Marsh P.R. and Staunton, M. (2020), 'Credit Suisse Global Investment Returns Yearbook 2020.

[15] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 64ff.

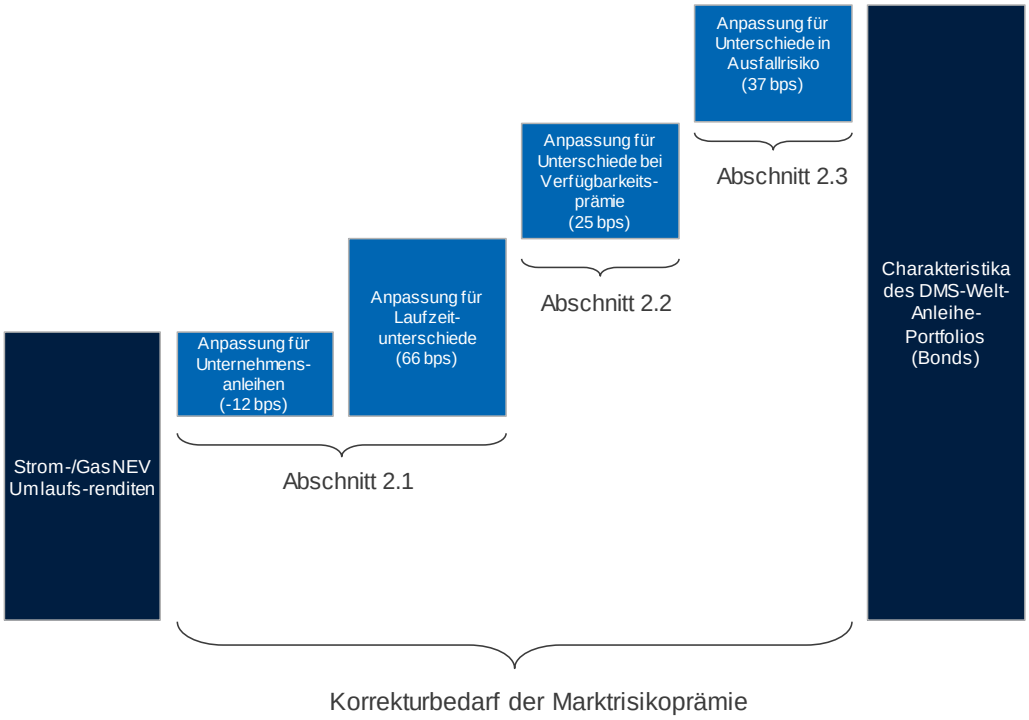
2 Adjustment of the risk premium

Frontier Economics take into account a possible adjustment of the risk premium in the form of a correction of the market risk premium.[16] Since the risk-free base rate according to Section 7 (4) StromNEV / GasNEV consists of a ten-year average of the current yields of fixed-income securities of domestic issuers, but the market risk premium is derived on the basis of realised yields of an international bond portfolio of different countries, Frontier Economics attempt to quantify the observable differences in the characteristics of the underlying bonds and adjust the market risk premium for these differences.

We follow the procedure and structure of Frontier Economics and correct the errors in the derivation of the adjustment requirement. The procedure for adjusting the market risk premium is stylized in the waterfall diagram in Figure 2.1

[16] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 64ff.

Figure 2.1 Stylized procedure for correcting Frontier Economics' market risk premium adjustments.



Note: Presentation only takes into account the differences in the characteristics of the underlying bonds. The effects from the different yield concepts (current yields vs. realised yields) are not included.

Source: Oxera representation.

The need for correction identified in this way does not take into account other possible causes of underestimation of the market risk premium, including improper application of a global CAPM model (Section 3.3), differences in the concept of returns (Section 4.1), and data quality problems resulting in inadequate weighting of countries with historically high equity returns (Section 4.2).

The StromNEV / GasNEV current yields include government and corporate bond yields. The DMS bond portfolio only includes government bond yields. Corporate bonds typically have higher yields than government bonds, so the market risk premium must be adjusted for the difference in yields including corporate bonds and government bond yields. In addition, the bonds included in the current yields have a much shorter remaining maturity than the DMS bond portfolio. Investors typically expect higher interest rates with a longer bond maturity, so the market risk premium must be adjusted for differences in the maturity premium. Frontier Economics perform both adjustments in one

step. In deriving this adjustment, however, Frontier Economics assume that the average maturity of the DMS bond portfolio is too short (cf. Section 2.1.).

In addition, Frontier Economics take into account that DMS bonds differ for Germany and for the rest of the world. Frontier Economics take into account differences in the availability premium. The availability premium theoretically reflects the premium that investors are willing to pay because government bonds are liquid or can be used as a means of payment or collateral.[17] Frontier Economics recognizes that German government bonds have a special position internationally and that the German availability premium differs from other countries in the DMS dataset. [18]Frontier Economics therefore attempt to quantify these differences in availability premia. However, this step of the analysis contains errors, because Frontier Economics try to derive the differences in availability premia compared to Germany using the difference in yields of German government bonds and the yields of a bond portfolio that is in turn dominated by Germany (see section 2.2).

Furthermore, as we show in our analysis, Frontier Economics misapply the concept of availability premia. [19]The adjustment made by Frontier Economics relates to the yield differential between Germany and Aaa-DMS countries in the euro area. We first correct errors in this Frontier Economics adjustment (Section 2.2) and then extend the analysis to additionally consider the impact of non-Aaa bonds in the DMS dataset (Section 2.3).

The DMS bonds differ in terms of their credit ratings. German government bonds have an Aaa rating, at least 13 countries of the DMS bonds have a lower rating. [20]A default risk premium reflects the premium an investor expects to pay for an investment in a government bond that has a low credit rating.

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[17] In the academic literature, the absolute size of the availability premium is determined by the difference between government bonds and corporate bonds, each with the highest credit rating (e.g. Aaa rating), see, for example, Feldhütter, P. and Lando, D. (2008), "Decomposing swap spreads", *Journal of Financial Economics*, **88**:2, pp. 375-405; Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), "The Aggregate Demand for Treasury Debt", *Journal of Political Economy*, **120**:2, April, pp. 233-67.

[18] Frontier Economics therefore does not conduct an analysis of the amount of an availability premium that needs to be taken into account when setting regulated equity rates. The analysis is therefore fundamentally different from that conducted in other countries, see Oxera (2021), "The cost of equity for RIIO-ED2", June; Oxera (2020), "Are Sovereign yields the risk-free rate for the CAPM? ", May.

[19] As discussed above, the availability premium reflects the premium that investors are willing to pay for government bonds relative to other securities (e.g. high quality corporate bonds). Frontier Economics does not conduct any analysis on the size of an availability premium that needs to be taken into account when setting regulated equity rates. The report therefore differs fundamentally from analyses conducted in other countries, see Oxera (2021), "The cost of equity for RIIO-ED2", June; Oxera (2020), "Are Sovereign yields the risk-free rate for the CAPM?", May.

[20] As of December 2020, referring to the 10-year period of Frontier Economics' analysis (which we correct in this report), we find that between 10 and 14 DMS countries were rated Aaa by Moody's Investors Service between January 1, 2011 and December 31, 2020.

Frontier economics have so far failed to adjust the world market risk premium for differences in default risk premia (see Section 2.3).

Frontier Economics make all adjustments to the market risk premium based on differences in forward returns[21]However, the DMS world market risk premium is calculated based on realized returns. Realized returns, as found in the DMS series, are a good approximation for forward-looking returns (StromNEV /GasNEV current returns) only when interest rates are stable. When interest rates fall, forward-looking returns fall, while realized returns rise. Our critique of the use of realized returns to determine the market risk premium can be found in section 4.1.

Frontier Economics quantify the adjustment requirement for the market risk premium using data from the last ten years. The market risk premium corresponds to a mean value from 121 years. Frontier Economics thus implicitly assume that the adjustment requirement based on data from the last ten years is representative of the entire 121-year period. If the calculated adjustment requirement is not observable in individual years, Frontier Economics assume a value of zero as the lower bound. Analogous to Frontier Economics, our calculations are also based on an average of the last ten years in order to make our results comparable to Frontier Economics. In addition, we report short-term results at the current margin. We consider an analysis period of only ten years to be already very short to determine the need for adjustment of a 121-year mean. We are of the opinion that the adjustment for the market risk premium should at least be based on a mean value of the past ten years (analogous to the averaging according to §7 Abs 4 StromNEV / GasNEV). Deviations of individual years from a trend always occur and can therefore not be interpreted as a lower limit for an adjustment of the market risk premium.

2.1 Adjustment for corporate bond yields and differences in remaining maturity

The risk-free base interest rate in accordance with Section 7 (4) StromNEV / GasNEV (current yields in total) is based on government and corporate bonds with a remaining term of approx. 6 to 7 years.[22] Only government bonds with

[21] Forward yields (current yields) assume that the investor holds the bond to maturity. The yield is equal to the internal rate of return on all future payouts. Realized yields assume that the investor holds the bond for only one period and then sells it at the prevailing market value. The yield therefore consists of coupon and, above all, price yields.

[22] We approximate the average residual maturity of the outstanding yields by weighting the residual maturities of those considered by the relative nominal value (data used: "All debt securities by residual maturity": Bundesbank (2020), "Capital Market Statistics March 2020: Statistical Supplement 2 to the Monthly Bulletin", p. 28).

longer maturities are considered in the DMS bond portfolio. For most countries, yields with a residual maturity of at least 10 years have been used since the 1990s; for the US, the "Ibbotson Associates' Long Bond Index" with a residual maturity of 20 years has been used consistently since 1926, and for the UK, a bond index with an average residual maturity of 20 years has been used since 1955. [23]Even with the conservative assumption that the residual maturity of bonds with ten or more years to maturity is exactly ten years, the average residual maturity of the DMS bond portfolio is approximately 16 years. [24]

The market risk premium must therefore be adjusted both for the difference between the "blended yields" of government and corporate bonds and the yields of government bonds and for maturity differences. Frontier Economics takes both differences into account at the same time by adjusting the market risk premium for the difference between the risk-free interest rate according to StromNEV / GasNEV and the yield derived from the yield curve of a zero-coupon bond based on listed federal bonds with a maturity of ten years (hereinafter referred to as "synthetic zero-coupon bond"). Frontier Economics determine an upper limit of 10 basis points from the mean value over the period from 2011 to 2020.

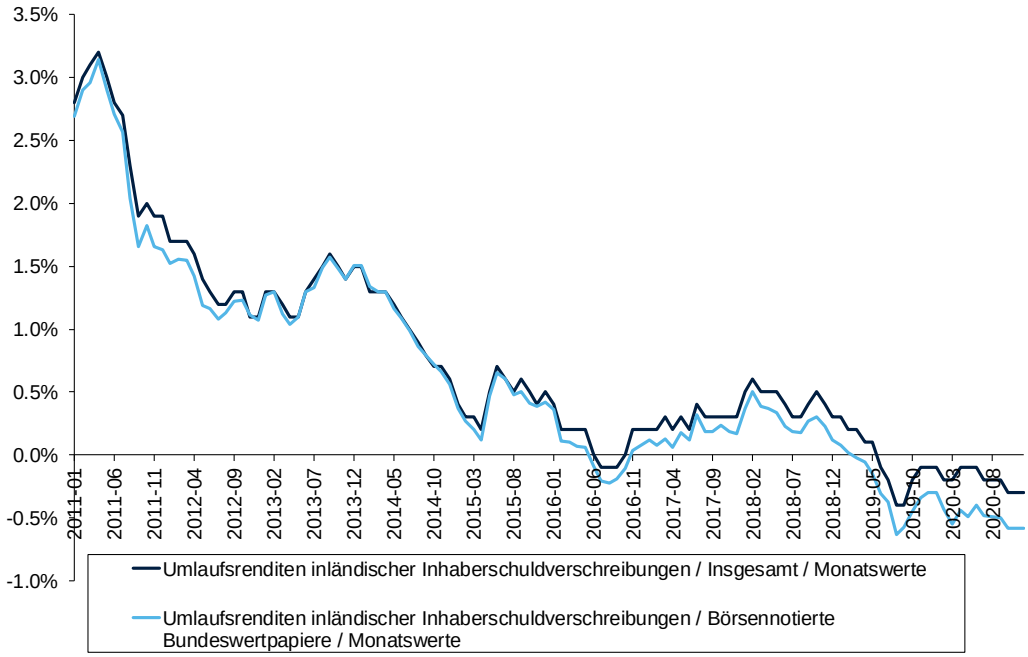
This total adjustment factor can be broken down into the following two components.

The first component comprises the consideration of corporate bond yields. If one compares the total current yields with the listed German government securities included in the current yields (cf. Figure 2.2), it can be seen that the yields on listed German government securities are lower than the total current yields. The difference amounts to 12 basis points on average.

[23] See Dimson, E., Marsh P.R. and Staunton, M. (2020), 'Global Investment Returns Database 2020.

[24] Based on the 23 original countries (including Russia and China) and relative GDP as weighting scheme (analogous to DMS). Countries with a residual maturity of "10Y+" are considered as 10Y. Countries with higher maturity as follows: Austria (15Y); China (20Y); United Kingdom (20Y); United States (20Y).

Figure 2.2 Comparison with total current yields on listed German Government securities

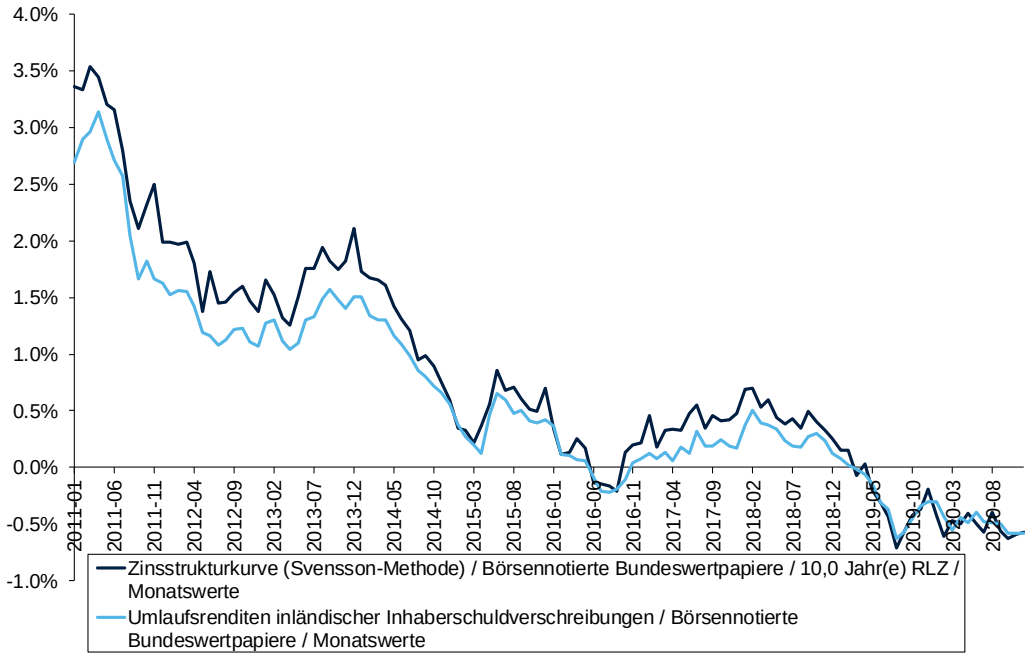


Source: Oxera calculations based on Bundesbank data. Time series "BBSIS.M.I.UMR.RD.EUR.A.B.A.A.R.A.A._Z._Z.A"; "BBSIS.M.I.UMR.RD.EUR.S1311.B.A604.A.R.A.A._Z._Z.A".

Since the DMS bonds relate exclusively to government bonds, Frontier Economics therefore (implicitly) increase the yields of the DMS bond portfolio by these 12 basis points. With regard to the consideration of corporate bonds, the market risk premium is thus placed in the same way as the risk-free base rate according to §7 StromNEV / GasNEV, so that the adjustment of the market risk premium is reduced by this amount.

The second component comprises the consideration of the term premium. In the case of a rising yield curve, higher interest rates are paid for longer remaining maturities (so-called maturity premium), either because the market expects higher interest rates in the future or because a longer commitment period is compensated with a liquidity premium and a risk premium, irrespective of the interest rate expectation. As a result, the calculated market risk premium based on long-term bond yields in the DMS dataset can be expected to be too low compared to the risk-free interest rate based on short-term bonds.

Figure 2.3 Comparison with current yields of listed German Government securities with zero coupon bonds (10-year residual maturity)



Source: Oxera calculations based on Bundesbank data . Time series "BBSIS.M.I.ZST.ZI.EUR.S1311.B.A604.R10XX.R.A.A._Z._Z.A"; "BBSIS.M.I.UMR.RD.EUR.A.B.A.R.A.A._Z._Z.A".

The term premium results from the difference between the listed German government securities included in the current yields and the yields of government bonds with a higher remaining term to maturity. Here, the residual maturity of this comparison series must be chosen to match the average maturity of the DMS equity portfolio. Frontier Economics suggest that the term premium could best be represented by a comparison with a synthetic zero coupon bond with a residual maturity of 10 years. [25]However, Frontier Economics do not present any evidence to confirm that the zero coupon bond used can reflect the maturity differences between the base rate and the DMS bonds. The term premium considered by Frontier Economics is shown in Figure 2.3and averages 22 basis points over the last 10 years. In particular, at the current margin, the term premium is not strong.

Although the choice of a synthetic zero-coupon bond with 10 years to maturity has methodological advantages for determining differences in the availability premium and default risks, since comparable synthetic yields are available for different countries and can therefore be compared (cf. Sections 2.2and 2.3), it

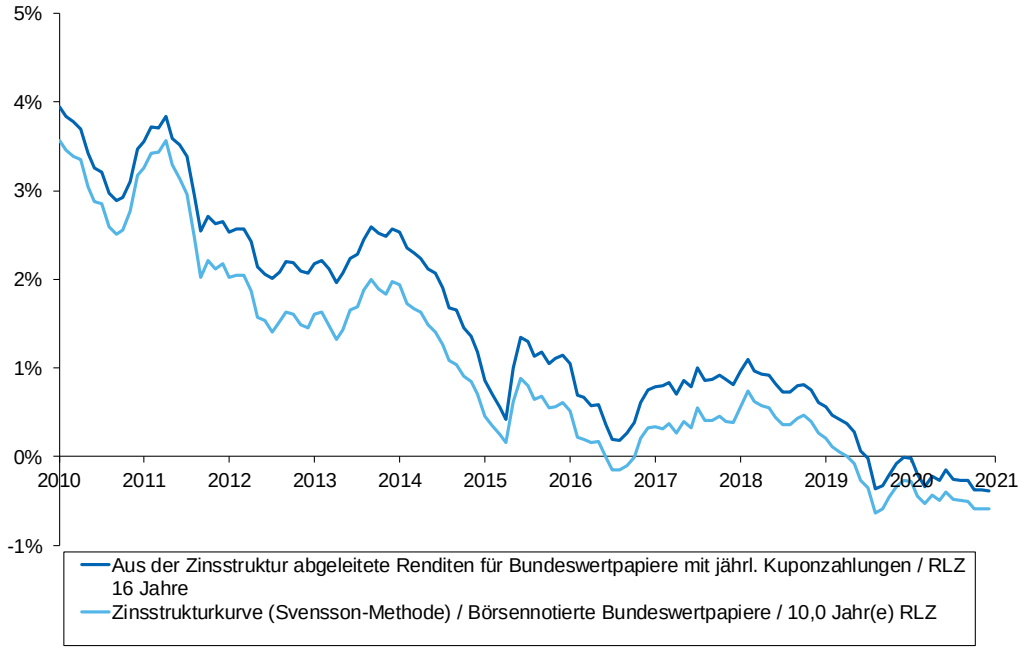
[25] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", p. 65f.

does not fully cover maturity differences. It can be assumed that the average maturity of the DMS portfolio is significantly longer than ten years. Although a zero coupon bond with a remaining term of ten years has a higher yield of 27 basis points compared to [26]a bond with the same term including coupon payments, it must be checked whether this higher yield of the zero coupon bond is sufficient to reflect the difference in yield to the DMS bond portfolio (with a conservatively estimated remaining term of at least 16 years, bonds including coupon payments).

We therefore compare the yield derived from the yield curve of a synthetic zero coupon bond with a remaining maturity of ten years with the yield of a synthetic government bond including coupon payments and a remaining maturity of 16 years. The results are shown in Figure 2.4The yield on a synthetic government bond including coupon payments with a remaining maturity of 16 years is consistently higher than the yields on a synthetic zero coupon bond with a remaining maturity of ten years, by 44 basis points on average. Frontier Economics' approach therefore fails to cover the maturity difference between the current yields and the DMS bond portfolio. The market risk premium adjustment needs to be increased by these 44 basis points compared to the Frontier Economics result. The term premium derived from the yield of a government bond including coupon payments with a 16-year residual maturity minus the current yields of listed German government securities thus totals 66 basis points.

[26] Calculated on the basis of a 10Y averaging of yield differentials over 2011 to 2020 between 10Y zero-coupon and coupon bonds (for Germany). Bundesbank time series: BBSIS.D.I.ZST.ZI.EUR.S1311.B.A604.R10XX.R.A.A._Z._Z.A / BBSIS.D.I.ZAR.ZI.EUR.S1311.B.A604.R10XX.R.A.A._Z._Z.A.

Figure 2.4 Comparison of a synthetic zero coupon government bond (ten years to maturity) with a synthetic government bond including coupon payments (16 years to maturity)



Source: Oxera calculations (monthly averages) based on Bundesbank data. Time series "BBSIS.D.I.ZST.ZI.EUR.S1311.B.A604.R10XX.R.A.A._Z._Z.A"; "BBSIS.D.I.ZAR.ZI.EUR.S1311.B.A604.R16XX.R.A.A._Z._Z.A".

The results of our analyses are shown in Table 2.1Averaged over ten years, the required market risk premium adjustment is 54 basis points (by comparison, Frontier Economics assume only ten basis points). The adjustment of the market risk premium (column 1) consists of a term premium of 66 basis points (column 2) minus the yield difference between the current yields according to §7 StromNEV / GasNEV (incl. corporate bonds) and government bonds of 12 basis points (column 3).

If only the latest estimate as of December 2020 is used as the basis for adjusting the market risk premium, the market risk premium would have to be adjusted slightly downwards; Frontier Economics assume an adjustment of zero basis points as the lower limit. However, this would mean assuming a relatively flat yield curve for the last 121 years, as the term premium in December 2020 was relatively low (in contrast, rising yield curves are normal [27]). We therefore consider a ten-year average orientation to be necessary in order to adjust the market risk premiums for the last 121 years.

[27] See, e.g., Hertrich D, "Normal Interest Rate Structure," available at https://www.gabler-banklexikon.de/definition/normale-zinsstruktur-60126, last accessed August 13, 2021.

Table 2.1 Adjustment for corporate bond yields and residual maturity differentials

	Adjustment of the market risk premium (1 = 2 – 3)	Term premium (2)	Difference between current yields (total) and government bonds (3)
Oxera	Yield of a government bond with a remaining term of 16 years incl. coupon payments less current yields (total, base rate according to §7 StromNEV / GasNEV))	Yield of a government bond with a residual term of 16 years incl. coupon payments less current yields of listed German government securities	Current yields (total, base rate according to §7 StromNEV / GasNEV)) less current yields of listed German government securities
Mean value over 10 years	0,54%	0,66%	0,12%
As of 12.2020	-0,08%	0,20%	0,28%
frontier economics	Yield on zero coupon bond (residual maturity 10 years) less current yield (total)		
Mean value over 10 years	0,10%	(0,22%)[a]	(0,12%)[a]
Lower limit	0%		

Source: Oxera calculations based on Bundesbank data: data series 'BBSIS.D.I.ZST.ZI.EUR.S1311.B.A604.R10XX.R.A.A._Z._Z.A'; 'BBSIS.M.I.UMR.RD.EUR.S1311.B.A604.A.R.A._Z._Z.A'; 'BBSIS.D.I.ZST.ZI.EUR.S1311.B.A604.R10XX.R.A.A._Z._Z.A'; 'BBSIS.D.I.ZAR.ZI.EUR.S1311.B.A604.R16XX.R.A.A._Z._Z.A'. Average over the period 2011 to 2020. [a] Frontier Economics determine only the full adjustment to the market risk premium. We have made the breakdown into the different components (in grey).

2.2 Differences in returns between Germany and other countries in the DMS data set

We agree with Frontier Economics that German government bonds have a special international position and an availability premium (convenience yield). We note that the analysis conducted by Frontier Economics did not attempt to quantify the availability premium in German government bonds. [28]Instead, Frontier Economics quantified the yield difference (15 basis points) between Germany and other DMS Eurozone Aaa government bonds. We agree that the yield differential between German government bonds and government bonds of other countries needs to be accounted for in the DMS bond portfolio. Accordingly, we first correct Frontier Economics' analysis of the availability premium differential between Germany and Aaa bonds in the euro area, and then extend the analysis to correct for the yield differential between Germany and non-Aaa bonds in the DMS bond portfolio (see next subsection).

[28] Oxera has published analyses based on academic and empirical evidence showing an availability premium for sovereign bonds of around 50-100 basis points. See e.g. Oxera (2020), "Are sovereign yields the risk-free rate for the CAPM?", prepared for the Energy Networks Association, 20 May.

The availability premium theoretically reflects the premium that investors are willing to pay because government bonds are liquid or can be used as payment or collateral. Frontier Economics does not conduct a standard analysis of the size of an availability premium that must be considered in setting regulated equity rates. [29]Instead, Frontier Economics undertakes a partial analysis. Frontier Economics take into account that German government bonds have a special position internationally, i.e. that the availability premium of German government bonds is more pronounced than the availability premium of other government bonds with high credit ratings. [30]As a consequence, German government bonds have a lower interest rate than comparable bonds of other sovereigns. Frontier Economics attempt to determine the differences in availability premia by comparing the yield of a synthetic zero-coupon bond with ten years to maturity from Germany with the yields of comparable bonds from Aaa countries in the eurozone and determines a premium of 0 to 15 basis points.

Within the eurozone, only Germany, Luxembourg (not part of the DMS portfolio) and the Netherlands currently have an Aaa rating. The benchmark index used by Frontier Economics can therefore only include these three countries. Germany is the largest economy of these three countries and it can therefore be assumed that the comparative index is dominated by German government bonds (unlike in the DMS bond portfolio, in which Germany only has a share of around 6%).[31] In principle, therefore, Frontier Economics compare the yields of a German government bond with the yields of predominantly German government bonds. It is therefore not surprising that the difference in availability premiums calculated in this way is relatively small.

Frontier Economics assume that the difference in availability premiums can be determined by comparing a German government bond with Aaa bonds from other countries. Within the DMS countries of the eurozone, this is only possible for the Netherlands (cf. Figure 2.5). The yields on Dutch government bonds are

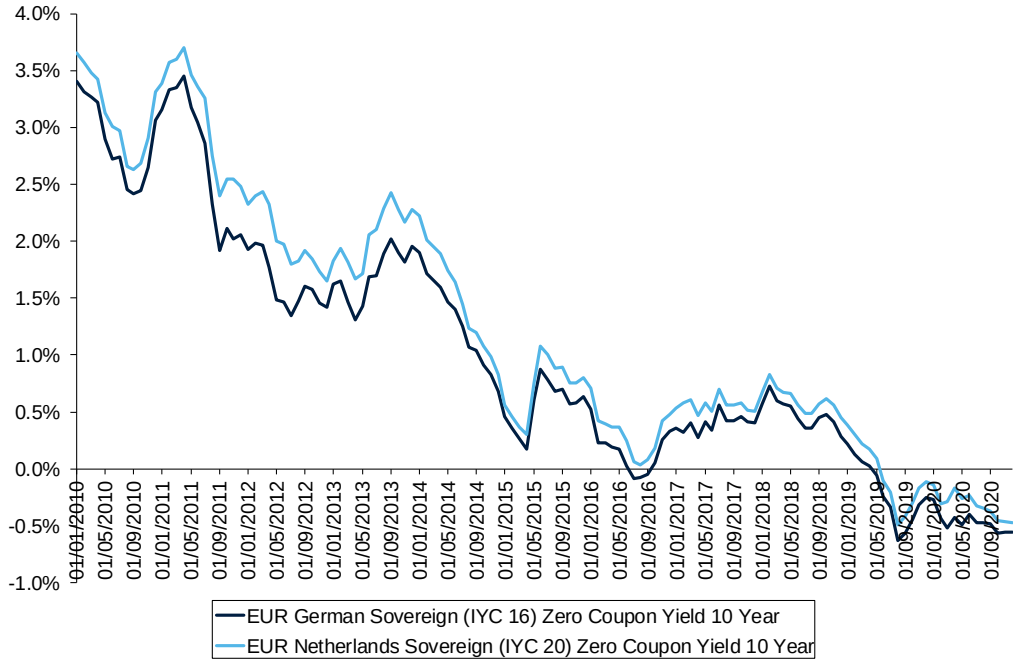
[29] In the academic literature, the absolute size of the availability premium is determined by the difference between government bonds and corporate bonds, each with the highest credit rating (e.g. Aaa rating), see, for example, Feldhütter, P. and Lando, D. (2008), "Decomposing swap spreads", *Journal of Financial Economics*, **88**:2, pp. 375-405; Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), "The Aggregate Demand for Treasury Debt", *Journal of Political Economy*, **120**:2, April, pp. 233-67.

[30] Note that this analysis does not determine the absolute level of the availability premium. Oxera (2021), "The cost of equity for RIIO-ED2", 4 June; Oxera (2020), "Are Sovereign yields the risk-free rate for the CAPM?", 20 May.

[31] Relative GDP of 2020 compared to the DMS 23 countries in the 2020 dataset (Data: World Bank World Development Indicators (GDP in current US$): https://data.worldbank.org/indicator/NY.GDP.MKTP.CD).

relatively stable above those on German government bonds over the period under consideration, by 22 basis points on average. [32]

Figure 2.5 Comparison of yields on German and Dutch synthetic zero-coupon government bonds (ten-year residual maturity)



Source: Oxera calculations based on data (daily values) from Bloomberg.

In general, this calculation is only feasible for one country in the DMS dataset, namely the Netherlands.[33] By analogy with Frontier Economics, it would therefore have to be assumed that the adjustment requirement determined is representative of all other countries in the DMS data set. The adjustment of the market risk premium (averaged over ten years) is determined by scaling the yield difference by the share of countries (not Germany), i.e. 0.22% x 0.94 = 0.21%.

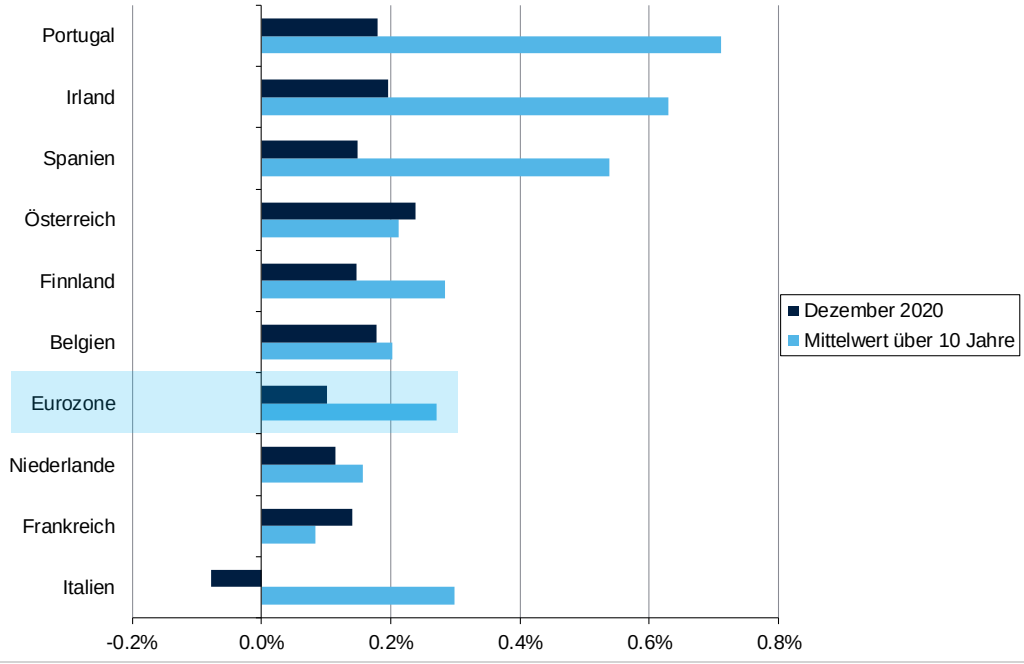
It should be noted that the observed yield differentials were referred to as an availability premium in the analysis conducted by Frontier Economics. However, there may be other factors (e.g. differences in default risk and liquidity) that could explain yield differences for bonds with the same maturity in the same currency. An alternative estimation method to determine the difference in availability

[32] We use only Bloomberg data series for these calculations to ensure that the synthetic zero coupon bonds are determined methodically in the same way.

[33] In addition, it is possible that there are credit quality differences between the Netherlands and Germany that are not fully captured by a rating. Credit quality differences need to be captured in addition to differences in the availability premium (see section 2.3).

premia of countries in the same currency zone has been developed by Jiang et al. (2020).[34] The basic idea of this method is that yield differences between two countries in the same currency zone are explained by differences in default risk and by differences in availability premium. If one adjusts the yield differences between two countries for differences in default risks (represented by the difference in credit default swaps spreads, see also section 2.3), one obtains, according to this method, an estimate of the differences in availability premiums. Using this method, it is therefore also possible to compare German government bonds with government bonds from countries that do not have the best credit rating. The advantage here is that it no longer has to be assumed that the adjustment requirement determined on the basis of the Netherlands is representative for all other countries in the DMS data set.

Figure 2.6 Estimation of the differences in the availability premium compared to Germany according to Jiang et al. (2020)



Source: Oxera calculations based on data (monthly averages) from Bloomberg. Mean value over the period 2011 to 2020. The mean value for the euro area takes into account all euro countries in the DMS dataset (except Germany) and weights the respective values with the relative gross domestic product of 2020 (cf. World Development Indicators of the World Bank (GDP in current US$): https://data.worldbank.org/indicator/NY.GDP.MKTP.CD).

The differences in availability premiums estimated using the method of Jiang et al. compared to Germany are shown in Figure 2.6The Netherlands and France show the lowest differences, Portugal, Ireland and Spain show the highest

[34] See Jiang, Z., Lustig, H.N., Van Nieuwerburgh, S. and Xiaolan, M.Z. (2020), "Bond Convenience Yields in the Eurozone Currency Union", 22 December, https://ssrn.com/abstract=3797321 or http://dx.doi.org/10.2139/ssrn.3797321.

differences. For the Netherlands, both calculation methods lead to slightly different results. In the Jiang et al. method, part of the difference in returns between the Netherlands and Germany is attributed to the difference in default risk premia. On average across all DMS euro countries, the method of Jiang et al. determines a need for adjustment of the market risk premium for default risk-adjusted return differentials in the amount of 27 basis points (averaged over ten years). If we assume, as above, that this adjustment requirement is representative of all DMS countries, the market risk premium must be adjusted by 25 basis points (0.27% x 0.94 = 0.25%).

Table 2.2 Correction of Frontier Economics adjustment for differences in availability premia

	Adjustment for default risk-adjusted differences between German and euro area yields
Oxera	
Yield differential between Aaa countries in the eurozone and Germany	Yield difference of 10-year zero coupon bonds of the Netherlands and Germany multiplied by the share of the remaining 22 countries in the DMS world bond portfolio (assumption: observable default risk premia for the Netherlands is representative for the rest of the world, i.e. scaling by 0.94)
Mean value over 10 years	0,21%
As of 12.2020	0,08%
Method of Jiang et al (2020).	Yield difference of 10-year zero-coupon bonds of the euro countries and Germany minus the difference of CDS premiums of the euro countries to Germany, weighted by relative GDP (assumption: observable default risk premiums for euro countries are representative for the rest of the world, i.e. scaling by 0.94).
Mean value over 10 years	0,25%
As of 12.2020	0,10%
frontier economics	Yield difference of zero-coupon bonds Aaa euro countries and Germany
Mean value over 10 years	0,15%
Lower limit	0%

Source: Oxera calculations based on data (monthly averages) from Bloomberg. Historical average over the period 2011 to 2020. For calculation details, see Figure 2.5and Figure 2.6.

The results of the calculations are summarized in Table 2.2The method of Jiang et al., which is based on a larger sample of countries, leads to an adjustment requirement of 25 basis points. Frontier Economics identify an adjustment requirement of only 15 basis points. If the most recent estimates are used for the adjustment, the adjustment requirement is reduced somewhat. Nevertheless, a correction for yield differences between German and foreign government bonds would be necessary even in the short term.

Note that the adjustment we make to the Frontier Economics availability premium is not a full correction to the market risk premium. It may not fully reflect differences across DMS countries. This is because DMS bonds include a mix of countries, many of which, unlike Germany, are not Aaa-rated. Therefore, further adjustment is required (see next section).

2.3 Differences in default risks between Germany and other countries in the DMS data set

Frontier Economics take into account differences in maturities and availability premia, but ignore differences in default risk across bonds. While German government bonds have an Aaa- rating and it can therefore be assumed that German government bonds are largely default-proof, only ten of the original DMS countries currently have an Aaa- rating from Moody's Investors Service.[35] For at least 13 countries, the rating agencies currently assume a higher default risk than for Germany (see Table 2.2). A default risk premium reflects the premium that an investor expects to receive for assuming the default risk. The DMS bond portfolio, which is used in determining the market risk premium to approximate the return on the risk-free investment, thus contains default risks. The market risk premium is thus understated by the default risk premium and it is imperative to adjust the market risk premium for these default risks.

[35] Referring to the 10-year period of Frontier Economics' analysis (which we correct in this report), we find that between 10 and 14 DMS countries were rated Aaa by Moody's Investors Service in the period from January 1, 2011 to December 31, 2020.

In the following, we focus on the 23 original DMS countries, as only these countries have been included in the DMS dataset since the beginning of the period under consideration and also comprised about 88% of the total world DMS bond portfolio in 2020 (based on World Bank GDP data: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD)).

Table 2.3 Creditworthiness of the countries in the DMS World Bond Portfolio

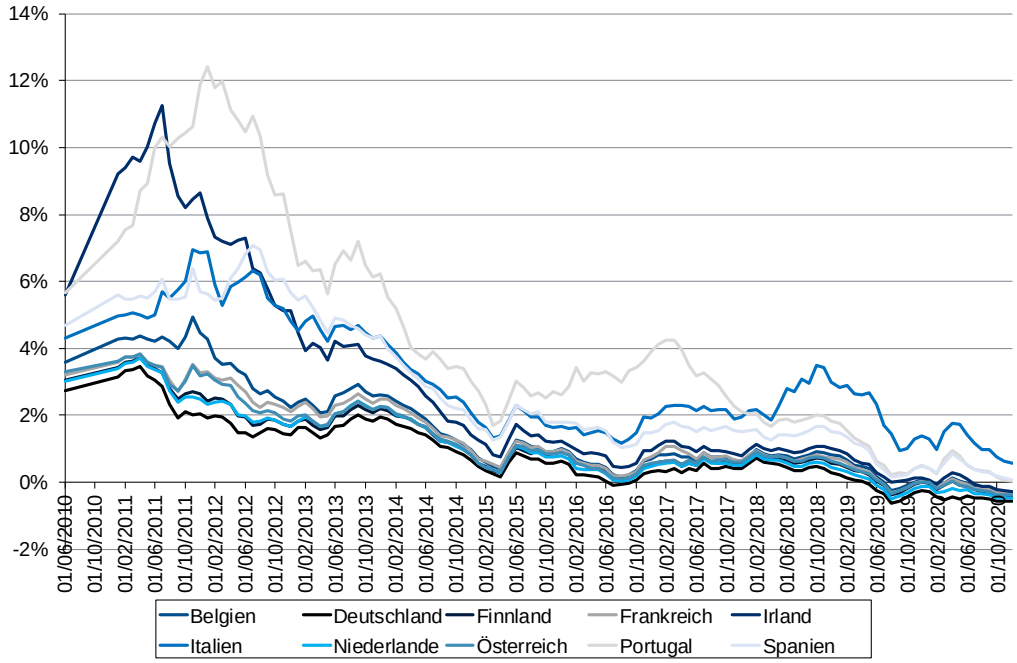
Country	Creditworthiness (Moody's credit rating)	
	Current	01.01.2011
Australia	Aaa	Aaa
Belgium	Aa3	Aa1
China	A1	Aa3
Denmark	Aaa	Aaau
Germany	Aaau	Aaau
Finland	Aa1	Aaa
France	Aa2	Aaa
Ireland	A2	Baa1
Italy	Baa3u	Aa2
Japan	A1	Aa2
Canada	Aaa	Aaa
New Zealand	Aaa	Aaa
Netherlands	Aaa	Aaau
Norway	Aaa	Aaa
Austria	Aa1	Aaa
Portugal	Baa3	A1 *-
Russia	Baa3	Baa1
Sweden	Aaa	Aaa
Switzerland	Aaa	Aaau
Spain	Baa1	Aa1 *-
South Africa	Ba2	A3
USA	Aaa	Aaa
United Kingdom	Aa3	Aaa

Note: The 'U' indicates that it is an unsolicited rating. Credit rating agencies may issue credit ratings on issues or issuers without a request from the issuer or its agent in order to meet the market's need for broader rating coverage.

Source: Bloomberg.

Chart 2.7shows that German and Dutch government bonds (the only two DMS euro countries currently with an Aaa rating) have by far the lowest yields, while government bonds from other countries consistently have significantly higher yields. The difference is particularly pronounced at the beginning of the period under review, triggered by the euro crisis; current yields are closer together.

Chart 2.7 Yields (zero coupon bonds with ten-year residual maturity) of euro area countries in the DMS dataset



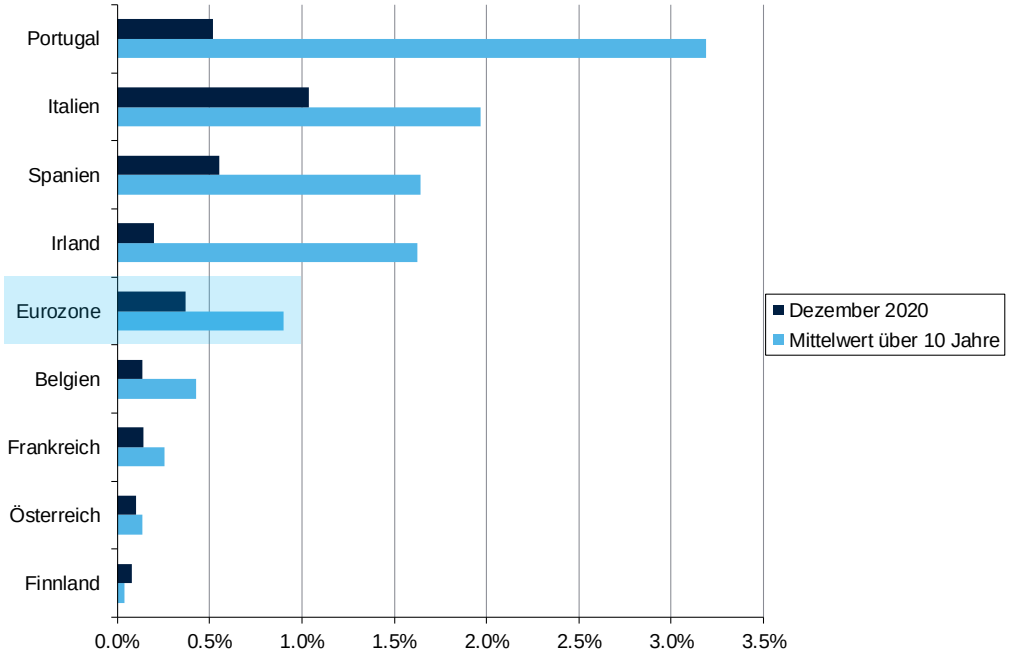
Source: Oxera calculations based on yields of zero coupon bonds with ten-year residual maturity (monthly averages) from Bloomberg.

These yield differentials for euro area countries could be driven by several factors, including differences in default risk, liquidity and the availability premium (see Section 2.2). In the analysis, it is important to ensure that there is no "double counting" between the 25 basis point premium estimated in Section 2.2 and the further premium required to account for the yield differential between Germany and the non-Aaa countries in the DMS world bond portfolio.

One approach to avoid double counting is to compare the yields of non-Aaa euro area government bonds with Dutch government bonds. As shown in section 2.2is a difference in yields between German and Dutch bonds, even though both countries have an Aaa credit rating. Comparing the yields of non-Aaa-rated eurozone government bonds with Dutch government bonds therefore highlights the further yield difference required to make German bonds comparable with non-Aaa-rated bonds from the DMS dataset. The calculated yield differences based on a comparison of euro area non-Aaa government bonds with Dutch government bonds are shown in Chart 2.8In particular, Portugal, Ireland, Italy and Spain (countries that were particularly affected by the euro crisis) show higher default risks. The average over ten years is higher than the most recent figure from December 2020, but these countries still have

considerable default risks compared with the Aaa countries. On average for the DMS euro countries, the difference in yields is 0.90% (average over ten years) and 0.37% (in December 2020).

Chart 2.8 Yield differentials between non-Aaa euro area government bonds and the Netherlands



Source: Oxera calculations based on yield differentials of zero coupon bonds with ten-year residual maturity of the respective countries to the Netherlands (monthly averages) from Bloomberg. Historical average over the period 2011 to 2020. The average for the eurozone takes into account all eurozone countries in the DMS dataset (except Germany, the Netherlands is included in the calculation with a value of zero) and weights the respective values with the relative gross domestic product of 2020 (cf. World Development Indicators of the World Bank (GDP in current US$): https://data.worldbank.org/indicator/NY.GDP.MKTP.CD).

Note that a direct comparison of returns can only be made for countries in the same currency area. By [36]analogy with Section 2.2one would therefore have to assume that the average risk premium for non-Aaa euro countries in the DMS dataset is representative of the rest of the world.

Alternatively, the default risk for all countries can be determined on the basis of credit default swap (CDS) spreads. CDSs are contracts between two parties under which a protection buyer pays a regular premium and receives a compensation payment from the protection seller in the event of a default. Provided CDS markets are sufficiently liquid and there is no default risk on the part of the protection seller (usually banks), CDS spreads for government

[36] If one compares the yields of two countries from different currency areas, one must also take into account the expected change in the exchange rate over the period under consideration.

bonds (here with a ten-year maturity) can be interpreted as a default risk premium.[37] CDS spreads only price the default risk, are expressed in basis points (per year) of the nominal amount and are therefore currency-independent. CDS spreads can therefore be compared across different currency zones.

It should be noted, however, that CDS spreads are also positive for Aaa government bonds (e.g. for Germany). This means that the market also sees a default risk (albeit a very small one) for these countries, which can, however, be priced. Analogous to the procedure in the literature, we therefore interpret the difference in CDS spreads compared to a default-proof bond (here a German government bond) as a default risk premium. [38]

The results are shown in Figure 2.9where we calculate a weighted average for the eurozone DMS countries and a weighted average for all DMS countries, each excluding Germany. Germany is not included in the graph and in the averages, as Germany is the reference country and the rest of the world is to be adjusted to the German default level (risk-free).

In addition to Portugal, Ireland, Italy and Spain, South Africa, Russia and China (i.e. countries with low credit ratings, see Table 2.3) also have high default risk premiums. In some countries, however, the calculated CDS differentials are slightly negative (e.g. in the US, Sweden, Switzerland and Norway), which may indicate low liquidity in the CDS markets. For the average of the DMS euro countries, both calculation methods (i.e. yield differences to the Netherlands and differences in CDS spreads) lead to very similar results.

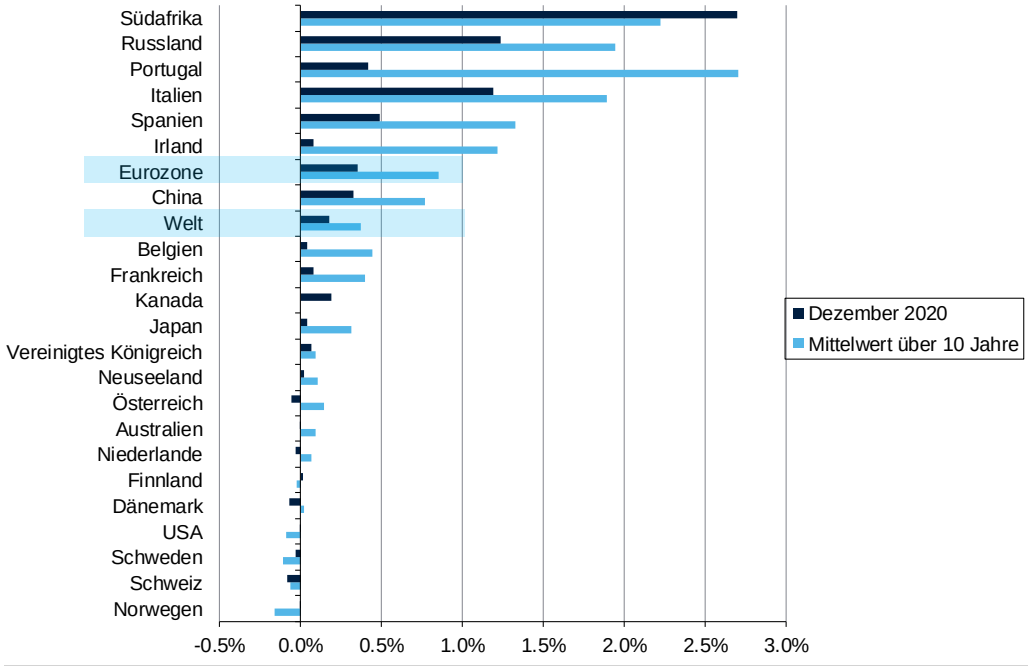
However, the assumption that European default risk premiums are representative of the rest of the world must be questioned. The average of the DMS countries shows significantly lower default risk premiums than the average of the DMS euro countries. In order to determine the correction required for the market risk premium, it therefore seems more appropriate to take into account default risks on the basis of CDS spread differences

[37] However, in particular due to liquidity risks in the CDS markets, it is possible that no pure default risk premium can be derived on the basis of CDS, see e.g. Badaoui, S., Cathcart, L. and El-Jahel, L. (2013), "Do sovereign credit default swaps represent a clean measure of sovereign default risk? A factor model approach", *Journal of Banking & Finance*, **37**:7, pp. 2392-2407.

[38] See Damodaran, Aswath, Country Risk: Determinants, Measures and Implications - The 2020 Edition (July 14, 2020). NYU Stern School of Business, available at https://ssrn.com/abstract=3653512, last accessed 16.08.2021.

averaged over all DMS countries, which amounts to 38 basis points on average over 10 years.

Figure 2.9 Default risk premiums based on CDS spreads



Source: Oxera calculations based on ten-year CDS spreads (difference of respective country and Germany, monthly averages) from Bloomberg. Historical average over the period 2011 to 2020. The average for the eurozone takes into account all eurozone countries in the DMS dataset (except Germany), the average for the world includes all original DMS countries (except Germany), in each case weighted by the relative gross domestic product of 2020 (cf. World Bank World Development Indicators (GDP in current US$): https://data.worldbank.org/indicator/NY.GDP.MKTP.CD). No continuous CDS spreads are available for Canada for ten years, so Canada was not included in the 10-year averaging.

The overall results are presented in Table 2.3Adjustment based on observed yield differences between Dutch (Aaa) and non-Aaa euro area government bonds (scaled by the share of the rest of the world in the DMS portfolio) is not recommended due to the non-representative sample. Instead, an adjustment based on CDS premiums should be made (also scaled, as Germany is not included in the mean calculation). The ten-year mean of 37 basis points turns out to be somewhat higher than the current estimate of 0.18%, especially since the current estimate is less influenced by the euro crisis. It should be noted, however, that a financial crisis is not a rarity in the last 121 years. [39]We

[39] See, for example, Reinhart, C.M. and Rogoff, K.S. (2011), "From Financial Crash to Debt Crisis", *American Economic Review*, **101**:5, pp. 1676-1706.

therefore consider an adjustment of the market risk premium based on a ten-year average of CDS premiums to be appropriate. [40]

Table 2.4 Adjustment for default risks

Method	Premium on the market risk premium
Observed yield differentials	Yield differential of zero coupon bonds with ten-year residual maturity between the respective non-Aaa euro countries and the Netherlands, weighted across all euro countries by relative GDP (assumption: observable default risk premia for euro countries are representative for the rest of the world, i.e. scaling by 0.94).
Mean value over 10 years	0,90%
As of 12.2020	0,37%
Differences in CDS premiums	Difference of CDS spreads to Germany, weighted by relative GDP, scaling by 0.94
Mean value over 10 years	0,37%
As of 12.2020	0,18%

Source: Oxera calculations based on zero coupon bond yields and 10Y CDS premia from Bloomberg (see figures for calculation details).

2.4 Total amount of necessary adjustments

Frontier Economics believe that an adjustment to the market risk premium of between 0 and 25 basis points is appropriate to address differences in the characteristics of the underlying bonds. The calculations we have provided show that this premium is significantly too low (see Table 2.5):

- The term premium determined by Frontier Economics is clearly too low, as the DMS portfolio currently has an average remaining term of at least 16 years.
- Frontier Economics' adjustment for the availability premium is misspecified. The Aaa yield differential of German government bonds compared to government bonds of other countries is too small, because Frontier Economics compare Germany to an index of European Aaa bonds dominated by Germany.
- Frontier Economics ignore that the DMS portfolio consists of, among other things, bonds that are not Aaa rated. These differences in credit default risks must be taken into account.

The range we present is based on quantified differences at the current edge of the time interval considered (lower bound) and a 10-year mean. Frontier

[40] Our estimate can also be considered conservative, as DMS added more countries with poor credit ratings in the most recent 2021 revision of the database (including India, Mexico, and Brazil), making the current DMS portfolio less creditworthy.

Economics calculate the market risk premium on the basis of a mean value over 121 years. It is not methodologically justifiable to make adjustments to the market risk premium solely on the basis of trend deviations of individual years. We consider an orientation towards the 10-year mean, i.e. an adjustment of the market risk premium by 116 basis points, to be necessary in order to at least address the differences in the characteristics of the bonds considered. [41]

Table 2.5 Market risk premium adjustment (total)

	Oxera		frontier economics	
	Current	**Mean value**	**Lower limit**	**Upper limit**
Adjustment of runtime differences	-0,08%	0,54%	0	0,1%
Correction to Frontier Economics' availability premium adjustment (Aaa yield spreads).	0,1%	0,25%	0	0,15%
Differences in default risks between Germany and DMS bonds (Aaa vs. non-Aaa rating)	0,18%	0,37%	- –	- –
Total	**0,19%**	**1,16%**	**0**	**0,25%**

Source: Oxera calculations based on data from the Bundesbank and Bloomberg.

[41] The need for correction identified in this way does not take into account other possible causes of underestimation of the market risk premium, including improper application of a global CAPM model (Section 3.3), differences in the concept of returns (Section 4.1), and data quality problems resulting in inadequate weighting of countries with historically high equity returns (Section 4.2).

3 Application of the global CAPM model

Frontier Economics use the global CAPM model and therefore assume integrated capital markets where investors diversify their capital internationally. In describing the advantages and disadvantages of the different capital market models to derive a preferable capital market model, Frontier Economics discuss the global and the international CAPM. Although Frontier Economics recognise that an additional risk premium for exchange rate risk must be taken into account in the event of a breach of purchasing power parity, Frontier Economics highlight practical difficulties in implementing the international CAPM and do not consider currency risk premia. [42]

Frontier Economics' approach raises three questions, which are addressed in this opinion:

- Even if one currently assumes integrated capital markets (here Frontier Economics do not argue consistently and only assume a European integration of capital markets to derive the beta factors), the question arises whether the assumption can also be made for the capital markets of the last 121 years (cf. Section 3.1).
- Even if one ignores the fact that the capital markets were not integrated during the 121-year period under consideration, the question arises as to whether currency effects actually play only an "insignificant" role in determining the market risk premium (cf. Section 3.2).
- Even if one is of the opinion that exchange rate risks do not need to be priced, the question arises as to whether the global CAPM has been applied consistently (cf. Section 3.3).

3.1 No full integration of capital marketsin the last 121 years

Frontier Economics justify the use of the global market risk premium by the increasing integration of capital markets. Global assets would be easier to invest in, leading to a reduction in home bias in portfolio data. Moreover, there

[42] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p.13.

would be evidence that equities in developed markets are not priced locally, but globally. [43]

Nevertheless, one cannot assume complete integration, but the markets would not be completely segmented either.[44]Frontier Economics therefore use a "mixed approach" that is unusual in the academic literature: to determine the market risk premium, Frontier Economics assume complete integration of the capital markets by using the world market risk premium; when determining the beta factors, Frontier Economics assume only integration within the eurozone and segmentation of the remaining countries (UK, US and Australia). [45]

It is also striking that Frontier Economics only justify (increasing) capital market integration at the moment, but largely depict the market risk premium on the basis of historical data. Frontier Economics do not cite any justification or empirical evidence that speaks for a complete capital market integration in the last 121 years.

The assumption of full capital market integration cannot be made for the last 121 years, since institutional capital market barriers existed in the first half of the 20th century and were also necessary after the end of the war to maintain the Bretton Woods exchange rate system.[46]This means: The assumption of complete capital market integration must be doubted especially when historical data are used to determine the market risk premium.

Insofar as historical data are used to determine the market risk premium, [47]the local CAPM should therefore be used, as proposed in our original report. If only perfect capital market integration can be assumed at present (even this can be doubted [48]), the results of alternative calculation approaches should be considered, which are also predominantly based on current data.

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[43] Frontier Economics (2021), "Scientific report on the determination of surcharges for entrepreneurial ventures of electricity and gas network operators: report for the Federal Network Agency", July, p.25.

[44] Ibid. S. 93.

[45] Ibid. S.49.

[46] See Mandilaras, A (2015), The international policy trilemma in the post-Bretton Woods era, *Journal of Macroeconomics*, 44(C): 18-32.

[47] Cf. Oxera (2021), Determination of the market risk premium on the basis of international data, p. 38ff.

[48] See, for example, Levy, L. and Levy, M. (2014), "The home bias is here to stay", *Journal of Banking & Finance*, **47**, pp. 29-40 ; Coval, J. and Moskowitz, T. (1999), "Home bias at home: local equity preference in domestic portfolios", *Journal of Finance*, **54**:6, pp. 2045-2073 ; Mishra, A. (2015), "Measures of equity home bias puzzle", *Journal of Empirical Finance*, **34**, pp. 293-312 .

3.2 Exchange rate risks do not play a subordinate role

Frontier Economics believes that currency effects play only a minor role in determining the world market risk premium, since the world market risk premium would correspond to an excess return of the equity portfolio compared to the bond portfolio and the currency effects would offset each other. A world market risk premium calculated as a USD excess return could therefore also be interpreted as a EUR excess return. [49]

This statement is demonstrably incorrect. Frontier Economics' argument refers exclusively to the last step of DMS's calculation, namely the representation of the world market risk premium as an excess return of two portfolios expressed in USD. The returns of the two portfolios $R_{t,t+1}^{USD}$: $BOND_{t,t+1}^{USD}, EQU_{t,t+1}^{USD}$ can each be converted into a different currency $s_{t,t+1}^{€,,USD}$ into a different currency:

$$1 + R_{t,t+1}^{€} = \left[1 + R_{t,t+1}^{USD}\right] \times s_{t,t+1}^{€,,USD}$$

By expressing the world market risk premium as an excess return, the exchange rate indices are mathematically truncated:

$$1 + MRP_{t,t+1}^{USD} = \frac{1 + EQU_{t,t+1}^{USD}}{1 + BOND_{t,t+1}^{USD}} = \frac{\left(1 + EQU_{t,t+1}^{USD}\right) \times s_{t,t+1}^{€,,USD}}{\left(1 + BOND_{t,t+1}^{USD}\right) \times s_{t,t+1}^{€,,USD}} = 1 + MRP_{t,t+1}^{€}$$

The excess return of the two portfolios is thus identical in each currency. This simple mathematical relationship does not mean, however, that currency effects generally play "a minor role" in determining the world market risk premium.

Frontier Economics ignore the influence of exchange rate effects in the composition of the respective portfolios. The starting point for the portfolio returns calculated by DMS are country-specific equity and bond indices in a local currency. The returns of the equity and bond portfolios are determined by converting the returns generated in local currency into USD. The portfolio return is determined as the weighted average (weighting factor ω_t^r(different for equities and bonds) of the local returns converted into USD:

$$R_{t,t+1}^{USD} = \sum\nolimits_i \omega_t^r(i) \times R_{t,t+1}^{USD}(i) = \sum\nolimits_i \omega_t^r(i) \times \left\{\left[1 + R_{t,t+1}^{LW}(i)\right] s_{t,t+1}^{USD,LW} - 1\right\}$$

[49] Frontier Economics (2021), "Scientific report on the determination of surcharges for entrepreneurial ventures of electricity and gas network operators: report for the Federal Network Agency", July, p. 93.

Due to the linear portfolio weighting and the different weighting schemes for equities and bonds, currency rates cannot be mathematically factored out when determining the market risk premium: [50]

$$1 + MRP_{t,t+1}^{USD} = \frac{1 + EQU_{t,t+1}^{USD}}{1 + BOND_{t,t+1}^{USD}} = \frac{\sum_i \omega_t^e(i) \times \left\{\left[1 + EQU_{t,t+1}^{LW}(i)\right]\boldsymbol{s_{t,t+1}^{USD,LW}} - 1\right\}}{\sum_i \omega_t^b(i) \times \left\{\left[1 + BOND_{t,t+1}^{LW}(i)\right]\boldsymbol{s_{t,t+1}^{USD,LW}} - 1\right\}}$$

This means that both the world equity and the world bond portfolios are influenced by currency effects (see also section 3.3).

Mathematically, a complete elimination of exchange rate risks can only be achieved if the market risk premiums are first determined on a country-specific basis and then averaged. The country-specific excess returns are currency-independent, analogous to the above calculation of the country-specific market risk premium. Converting the country-specific returns into another currency before calculating the excess return does not change the result of the excess return.

In our expert opinion for Netze BW, we showed that this alternative approach (i.e. averaging country-specific market risk premiums) allows the market risk premium to be derived robustly and is consistently significantly higher than the world market risk premium used by Frontier Economics, irrespective of the weighting scheme used.[51]principle, this approach assumes a local CAPM and approximates the market risk premium from a weighted average of different countries in order to compensate for special historical factors of individual countries.

3.3 Inconsistent application of the global CAPM

The DMS world market risk premium combined with German current yields as a risk-free base rate is not consistent with any of the financial market models described in the Frontier Report. [52]We are not aware of any scientific application of the CAPM that determines the market risk premium based on realized returns of an international bond portfolio and links this market risk

[50] For an illustrative example, see Oxera (2021), "Determining the market risk premium based on international data," pp. 57 and 58.

[51] Cf. Oxera (2021), "Determining the market risk premium based on international data", 10 March, p. 42ff.

[52] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 10ff.

premium to a local risk-free interest rate. The risk-free base rate and the risk-free bond yield must refer to the same bonds.

Frontier economics addresses this fundamental problem insofar as the differences in the characteristics of the bonds are at least partially taken into account in the risk-free base rate and the market risk premium (cf. section 2). However, these adjustments do not take into account the inherent exchange rate risks (cf. Section 3.2).

From the point of view of capital market theory, exchange rate risks can theoretically be a component of a risky market portfolio, provided that investments in foreign markets are possible and desired (i.e. there are no capital market restrictions or a "home bias"). However, the global CAPM can only be applied if purchasing power parity holds. If purchasing power parity does not hold, currency risks must be additionally priced. [53]

From a capital market theory perspective, however, the (local or global) market portfolio must be compared with a risk-free investment. Accordingly, the bond portfolio used must not contain any risks, i.e. also no exchange rate risks. However, due to the portfolio approach used by DMS to determine the returns of the international bond portfolio, the "risk-free" bond contains exchange rate risks (cf. Section 3.2). A simple adjustment of the market risk premium for observable differences in the characteristics of bonds (cf. Section 2) is therefore not sufficient to make the bonds comparable for determining the risk-free base rate and for determining the market risk premium.

A consistent application of the global CAPM model would be achieved if the return on a global equity portfolio (converted into the investor's local currency) is compared with the return on local risk-free government bonds. In simple words, a US investor compares the return of the market portfolio converted into USD with the returns of a US government bond.[54] A German investor obtains the return of the market portfolio in € (in the past in DM, Reichsmark or Mark) and compares this return with the return of a risk-free German government

[53] See, for example, Adler, M. and Dumas, B. (1983), "International portfolio choice and corporation finance: A synthesis", *Journal of Finance*, **38**:3, pp. 925-84.

[54] For an application of the global CAPM to the US, see, for example, Mishra, D.R. and O'Brien, T.J. (2001), "A Comparison of Cost of Equity Estimates of Local and Global CAPMs", *The Financial Review*, **36**:4, pp. 27-48; O'Brien, T.J. (1999), "The Global CAPM and a Firm's Cost of Capital in Different Currencies", *Journal of Applied Corporate Finance*, **12**:3, pp. 73-79.

bond. [55]This is all the more true since the risk-free base rate is fixed on German current yields.

These calculations would be easy to implement in the present DMS data set: The recalculation of the market risk premium only requires a conversion of the returns of the world equity portfolio into the respective local currency (the respective currency indices are available) and the calculation of the excess return using the local bond return (in the respective currency, is also available). [56]

According to this calculation of a global CAPM model, a German investor would have achieved an extraordinarily high return of 14.29%[57] in nominal terms in German currency if a large part of his assets had been invested outside Germany (even though this was in fact not possible at all due to capital market restrictions). This result is largely due to capital market conditions, including exchange rate fluctuations, in the first half of the 20th century. [58]However, it is unlikely that such large exchange rate fluctuations will be repeated in the near future or that an investor would expose himself to such a high currency risk without expecting compensation for this risk. For this reason, we do not believe that the use of a "global" CAPM is appropriate and clearly advocate a local CAPM in our original report. A local CAPM can circumvent exchange rate risks, apply the CAPM consistently, and smooth out national special effects by averaging local market risk premia. [59]However, if frontier economists want to continue to assume perfect capital market integration without taking exchange rate risks into account as a risk factor, the global CAPM must at least be applied consistently and, as a result, the market risk premium must be raised significantly. [60]

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[55] For an application of the global CAPM from a German perspective, see Ruiz de Vargas, S. and Breuer, W. (2018), "Corporate *Valuation* in an International Context with the Global CAPM from a German Perspective", in Schwetzler/Aders (Eds.), *Jahrbuch der Unternehmensbewertung 2016, pp.* 129-141 and pp. 143-155, BewertungsPraktiker 2/2015, pp. 50-60, BewertungsPraktiker 1/2015, pp. 2-13; for non-US countries in local currency Ejara, Demissew Diro and Krapl, Alain A. and O'Brien, Thomas J. and Ruiz de Vargas, Santiago, Local, Global, and International CAPM: For Which Countries Does Model Choice Matter? (May 16, 2020). *Journal of Investment Management*, 2nd Quarter, 2020, University of Connecticut School of Business Research Paper No. 18-04.

[56] Alternatively, the excess return of the world equity portfolio and the local bond return in USD can also be determined. The results are identical.

[57] Arithmetic mean over the period 1990 to 2020. DMS world stock returns (in USD, nominal) divided by German bond returns (in USD, nominal) of the 2020 DMS dataset.

[58] In Germany, the results are driven in particular by the changeover from the mark to the Rentenmark (1923/1924) and the currency reform at the end of the war.

[59] Cf. Oxera (2021), "Determining the market risk premium based on international data", 10 March, p. 42ff.

[60] With a consistent implementation of the global CAPM, there is no need to take into account the differences in default risk-adjusted yields and default risks (cf. Sections 2.2and 2.3). However, a term

premium and possibly default risks in German government bonds in the first half of the 20th century still have to be taken into account.

4 Use of historical DMS data

4.1 Price effects for equities and bonds

The Federal Network Agency links a current forward-looking current yield as a risk-free base rate with a market risk premium, which is determined on the basis of a long-term average of realised yields. In material terms, this means: for the risk-free base rate, Frontier Economics assume a value of 0.74%, while for determining the market risk premium Frontier Economics assume a long-term average of 5.2%. [61]

The reason for this high discrepancy lies, among other things, in the long-term lowering of the interest rate level (in addition to differences in bond characteristics and currency conversions, see Sections 2and 3.2). This lowering has two consequences: first, the current risk-free interest rate level is lower than the interest rate level in the past. Second, when interest rates fall, the price of an asset rises because future payoffs are discounted at a lower rate. As a result, realized bond yields are comparatively higher, while forward-looking yields decline. [62]

Frontier Economics believes that this high discrepancy between the current low level of interest rates and the high realised bond yields used to determine the market risk premium is not a cause for concern. Stock and bond prices would be expected to be affected to the same extent by an interest rate cut. [63]

However, this assumption has neither a capital market theory nor an empirical foundation. If equity and bond prices represent the discounted sum of future payments (e.g. dividend payments in the case of equities and coupon and redemption payments in the case of bonds), the impact of an interest rate cut on the prices of bonds and equities (the percentage change in prices in response to a change in the interest rate is called the modified duration) depends on different factors in each case. For stocks, duration depends on the level of the market risk premium, dividend growth, and the impact of the

[61] See Dimson, E., Marsh P.R. and Staunton, M. (2021), "Credit Suisse Global Investment Returns Yearbook 2021", p. 201 (mean of arithmetic and geometric mean).

[62] See also Bandle, N., Burger, A., Deuchert, E., Gabel, M., Hope, P. and Woolley, F. (2020), "Why the market risk premium needs to be significantly increased in determining regulatory capital rates", *Energy Economics Daily Matters*, **70**:12, pp. 58-61 .

[63] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 94.

nominal interest rate change on expected dividend growth.[64] The duration of a bond, on the other hand, is primarily influenced by the remaining term of the bond.

Since the duration of stocks and bonds depends on different factors, the following conclusion of Frontier Economics is not correct:

> However, this effect also applies to equities, as expected future cash flows are discounted at a lower discount rate and thus realized equity performance is also positively affected by falling interest rates. **The market risk premium estimated using historical realized returns on equities and long-term bonds is therefore not distorted by an interest rate decline trend and can be used as an estimator of the future market risk premium.** (cf. Frontier Economics 2021, p. 94, emphasis added).

In the DMS dataset, the selection of bonds is predominantly driven by data availability and is not based on considerations of whether the durations of the two assets match. A comparison of realized stock and bond returns can only determine the market risk premium if stocks and bonds have the same duration. If, for example, a reduction in interest rates leads to a higher price increase for bonds than for equities, the market risk premium can be assumed to be incorrectly estimated.

The duration of bonds can be determined empirically using a regression approach in which the change in (price) returns is explained by a change in the interest rate level.[65]We are not aware of any scientific research on the duration of the DMS equity portfolio. Available studies on the duration of country-specific equity portfolios suggest that the duration of equity portfolios is significantly more volatile over time than the duration of a bond portfolio (i.e. in principle, therefore, a bond portfolio with constant duration cannot be used to determine the market risk premium); moreover, the empirically measured duration of the bond portfolio is often larger than the duration of an equity

[64] See Leibowitz, M.L., et al. (1989), "A Total Differential Approach to Equity Duration", *Financial Analysts Journal*, **45**:5, pp. 30-37. The authors also assume that a change in the interest rate affects the risk premium, but Frontier Economics categorically rules this out, again without sufficient empirical or capital market theoretical foundation.

[65] Alternative methods of calculation derive equity duration on the basis of a theoretical model, although for equities in particular the future payouts, the effect of an interest rate cut on future payouts and the level of the internal rate of return (and hence the market risk premium) must be assumed to be known (see, for example, Dechow, P.M., Sloan, R.G. and Soliman, M.T. (2004), "Implied Equity Duration: A New Measure of Equity Risk", *Review of Accounting Studies*, **9**, pp. 197-228). An estimate of these effects is subject to high uncertainty.

portfolio. [66]There is therefore a risk that, due to large increases in bond prices since the late 1970s, the DMS market risk premium is systematically underestimated by comparing realized stock and bond returns. We have therefore presented sensitivity analyses using bond yields on short-term bonds ("Bills") as a possible upper bound on the market risk premium. [67]

4.2 Data quality

Frontier Economics rely solely on the DMS database to derive the market risk premium, arguing that it is the best available database that is regularly improved and expanded. [68]No assessment of the underlying data quality is made, as DMS data do not allow for independent verification of data quality. Relevant components (in particular the weighting scheme for compiling the world equity portfolio) are neither published nor adequately described.

There are doubts about the underlying data quality. [69]The results presented show the peculiarity that the calculated average across all countries (especially stock returns) is significantly lower than most local stock returns and in particular deviates strongly from those countries that should actually have a high weight in a global consideration. [70]

Frontier Economics consider that the (current) weighting scheme is plausible and that the data sources provided by DMS are sufficiently detailed to replicate the weighting scheme theoretically (but with disproportionate effort).[71] The discrepancy described is less pronounced on a geometric mean basis and can be explained if country weights change over time and high relative market

[66] See, for example, Reilly, F.K., Wright, D.J. and Johnson, R.R. (2007), "Analysis of the Interest Rate Sensitivity of Common Stocks", *The Journal of Portfolio Management*, **33**:3, pp. 85-107; Korkeamäki, T. (2011), "Interest rate sensitivity of the European stock markets before and after the euro introduction", *Journal of International Financial Markets, Institutions and Money*, **21**:5, pp. 811-831; Leibowitz, M.L. (1986), "Total Portfolio Duration: A New Perspective on Asset Allocation", *Financial Analysts Journal*, **42**:5, pp. 18-29.

[67] Cf. Oxera (2021), "Determining the market risk premium on the basis of international data", p. 48ff. However, since Frontier Economics takes term premiums into account when determining the market risk premium, this must be redetermined (cf. Section 2.1).

[68] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 31.

[69] The DMS database is a linkage of different sources for national markets. Securities prices are not measured at the same point in time, the underlying securities indices are not identical and methodologically created differently, and the market coverage of the respective local markets is not complete, see e.g. Moore, L. (2010), "World Financial Markets 1900-25", Working paper.

[70] Cf. Oxera (2021), Determination of the market risk premium based on international data, 10 March, p. 20ff.

[71] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 90.

capitalization is followed by lower returns. However, Frontier Economics does not provide evidence for this assumption.

Replicability of the weighting scheme

Frontier Economics defend the plausibility of the most recent weighting scheme, but [72]ignore that the market risk premium is determined based on data from the last 121 years. In particular, we have expressed doubts about the historical data. [73]The historical weighting scheme cannot be replicated because it is based on some named data sources and numerous unnamed data sources ["numerous country sources"] that [74]were only discovered in 2012. Frontier Economics' claim that the weighting scheme can be taken from DMS's 2002 and 2007 publications is therefore incorrect. [75]

None of the data sources mentioned by DMS allow for a consistent weighting scheme for all years and for all countries, as data were only collected for certain dates or countries (in some cases even only for individual stock exchanges). How DMS filled in the remaining gaps or which data were ultimately used when two different sets of data are available for the same point in time is unclear. Even with "disproportionate effort", it is therefore not possible to derive a weighting scheme for all countries from the limited information provided by DMS.

Reason for the low world equity return

We showed in our original report that the rationale for the discrepancy between the world market risk premium and country-specific market risk premia is predominantly driven by the low average return of the world equity portfolio. Frontier Economics suggest that this discrepancy can be explained by changing weights over time, as high relative market capitalisation is followed by lower returns.

The relationship assumed by Frontier Economics can be represented statistically by dividing the expected value of the world stock return into its components:

[72] Ibid, pp. 90-91

[73] See Oxera (2021), Determining the market risk premium based on international data, 10 March, p. 24.

[74] See Dimson, E., Marsh, P. and Staunton, M. (2020), "Credit Suisse Global Investment Returns Yearbook 2020", p. 227.

[75] Cf. Frontier Economics (2021), "Wissenschaftliches Gutachten zur Ermittlung der Zuschläge für unternehmerische Wagnisse von Strom- und Gasnetzbetreibern: Bericht für die Bundesnetzagentur", July, p. 90.

$$E[EQU^{Welt}] = \sum E[\omega_i]E[\mathrm{EQU}_i] + Cov[\omega_i, \mathrm{EQU}_i]$$

If the weighting scheme were fully available, the relationship between relative market capitalization and country-specific returns, expressed by the covariance (Cov), could be examined.

However, the complete weighting scheme is not available. From the DMS data, a weighting scheme can only be implicitly derived for the US from the comparison of equity portfolio returns for the world, world excluding the US and the US. [76]The conjecture of Frontier Economics can then be considered in more detail, at least with the help of the derived weighting scheme for the USA.

No strong correlation between the implied weighting scheme and stock returns is discernible for the US (covariance: -0.09%); only for the rest of the world is a somewhat stronger correlation discernible (covariance: -0.53%). The relationship between relative market capitalization and returns lowers the mean of the world equity portfolio by 0.62 (= 0.09+0.53) percentage points. We showed a similar effect in our original report. If we average the individual market risk premia by a dynamic weighting using the respective GDP, the average falls slightly compared to a fixed weighting. Nevertheless, the results we obtain using dynamic weighting are still well above the DMS world market risk premium, both in geometric and arithmetic mean terms.[77] The relationship assumed by Frontier Economics can therefore only explain a small part of the discrepancy between the DMS-determined world market return and the returns of relevant countries.

The discrepancy between the DMS-determined world market return and the returns of relevant countries is therefore probably due to the weighting scheme itself. The limitations of the original sources cited by DMS for determining the historical weightings are well known in the literature.[78] For example, the original sources refer only to individual stock exchanges but not to the entire country, the source data subsume stock and bond markets, foreign stocks are not

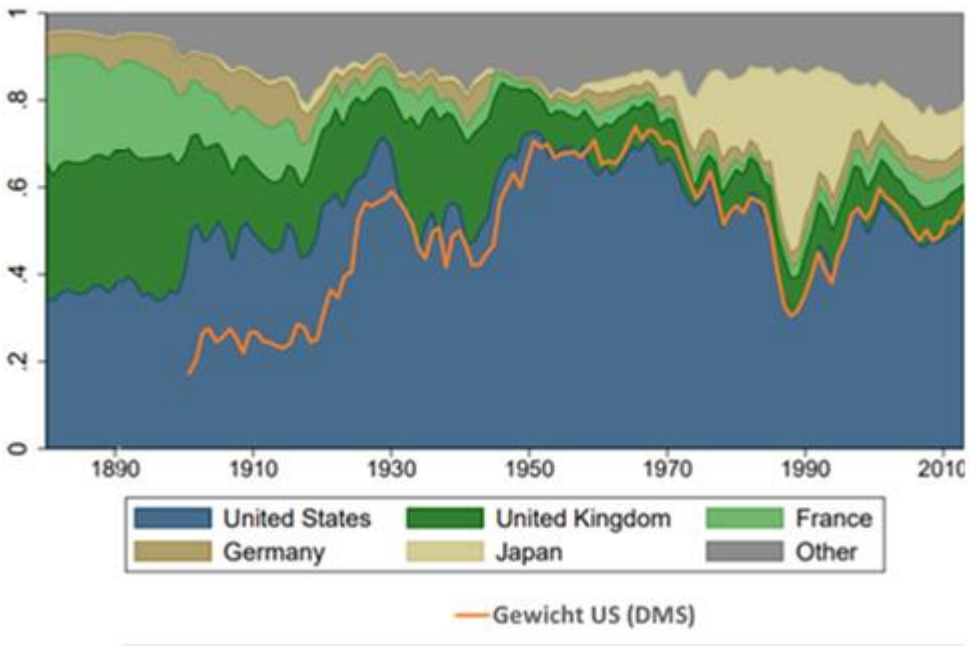
[76] DMSs map both returns for the US, for the world, and for the world excluding the US. The weighting scheme for the US can be obtained as follows: $\omega_t^{USA} = \left(EQU_{t,t+1}^{Welt} - EQU_{t,t+1}^{Welt/USA}\right) / \left(EQU_{t,t+1}^{USA} - EQU_{t,t+1}^{Welt/USA}\right)$.

[77] See Oxera (2021), "Determining the market risk premium based on international data," 10 March, p. 43 (Figure 5.4).

[78] See Kuvshinov, D. and Zimmermann, K. (2021), "The Big Bang: Stock Market Capitalization in the Long Run," available at https://dkuvshinov.com/wp-content/uploads/2018/09/big_bang_latest.pdf, last accessed 08/17/2021, for a discussion of data sources.

removed in the calculation of domestic market capitalization, and no correction is made for stocks traded in multiple domestic stock markets. The extent to which the various data sources differ in estimating market capitalization is shown in the detailed data appendix by Kuvshinov and Zimmermann. [79]

Figure 4.1 Comparison of different estimates for US market share (Kuvshinov/Zimmermann and DMS)



Source: original graph by Kuvshinov. D. and Zimmermann, K. (2021), "The Big Bang: Stock Market Capitalization in the Long Run", https://dkuvshinov.com/wp-content/uploads/2018/09/big_bang_latest.pdf. The orange line is based on an Oxera calculation based on the DMS dataset (Dimson, E., Marsh P.R. and Staunton, M. (2020), Global Investment Returns Database 2020, distributed by Morningstar Inc).

Although DMS's weighting scheme cannot be reproduced entirely, at least the implicitly derived weighting scheme for the U.S. can be reconciled with current research that addresses the errors described in the original sources (see Figure 4.1). While for current periods the weighting scheme for the U.S. is largely consistent, DMS appear to significantly underestimate the U.S. market share until the mid-1930s. During this period, U.S. stock returns were nearly twice those of the rest of the world. This observation indicates that average world stock returns are underestimated by a systematic underestimation by DMS of the market share of high-yielding countries.

The approach of frontier economics focusing only on one method and one data set (each of which is fraught with significant problems) in deriving the market

[79] Ibid. Data Appendix, A12ff.

risk premium, without even considering the results of alternative data sets and calculation methods, is therefore not robust.

5 Overall conclusion

The Federal Network Agency assumes a market risk premium of 3.7% when setting the regulated equity capital interest rates and puts an adjustment of 0 to 25 basis points up for discussion in order to address the discrepancies in returns between the risk-free base rate pursuant to Section 7 (4) StromNEV / GasNEV and the (risk-free) return used to calculate the market risk premium.

Our calculations suggest that adjusting the market risk premium by 0 to 25 basis points is not sufficient:

- Frontier Economics underestimates the maturity differences between current yield bonds and DMS bonds and therefore also underestimates the required premium for the term premium.
- Frontier Economics' availability premium adjustment is misspecified. The Aaa yield differential for German government bonds compared to government bonds of other countries is too low because Frontier Economics compares Germany to an index of European Aaa bonds dominated by Germany.
- Frontier Economics do not take into account that DMS bonds differ from German bonds in terms of their default risk.

After correcting for these errors, we believe that a conservatively derived 116 basis point adjustment to the market risk premium is necessary to at least compensate for the differences in the characteristics of the underlying bonds in the risk-free base rate and the market risk premium.

However, the adjustment of the market risk premium does not solve all the problems of the Frontier Economics approach. Our criticism relates both to the application of the global CAPM, as well as its improper implementation and the use of the DMS data.

Frontier Economics argue that capital markets would be integrated currently and in the future, but map the market risk premium on the basis of data that can be demonstrably considered non-integrated at the time. This ignores exchange rate risks by stating that these risks would play no role in determining the market risk premium, which is demonstrably false. Moreover, the global CAPM has not been properly implemented. A proper implementation of the global CAPM leads to a significant increase in the market risk premium.

The historical data used (DMS dataset) carries a high risk of underestimating the market risk premium. DMS use realised equity and bond returns to derive the market risk premium. Falling long-term interest rates lead to rising bond yields, which results in combining a currently very low risk-free base rate with a high realized bond yield to determine the market risk premium. The DMS weighting scheme for determining the return on a world equity portfolio underestimates the relevance of high-yield equity markets (especially the US), particularly in the first half of the 20th century.

In the overall view of all the results, we consider a significant adjustment of the market risk premium to be imperative in order to ensure an appropriate, competitive and risk-adjusted return on the equity employed.

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