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Applying the global CAPM. A note for valuation practitioners

Santiago Ruiz de Vargas*

When using the CAPM, valuation practitioners should be aware that the diversification principle applies. For rational investors, well-integrated capital markets of developed countries provide an expanded universe of capital assets and financial securities that define a *global market portfolio*. For such investors, a global market portfolio (and not the domestic portfolio of an individual country) reflects the relevant expected returns and systematic risk in a business valuation. Thus, the global (and neither the local or domestic) CAPM is applicable. This note provides guidance for practitioners on how to use the global CAPM from the standpoint of investors that use the euro as their reference currency. In addition, it demonstrates that the CAPM also implies application of the (risk-adjusted) forward rate method as the consistent method to forecast future exchange rates.

I. Introduction

In the practice of business valuation, the Capital Asset Pricing Model (CAPM) remains the dominant method for estimating the risk premium of the discount rate. This dominance is attributable to the conceptual relationship with the net present value methods applied in practice to estimate the value of a corporation, particularly the different approaches related to the discounted cash flow method (DCF method). However, this prevalence is assignable not only to the CAPM's broadly accepted theoretical foundation and consistency with the DCF methodology, but also to the fact that the related capital markets-based estimate of the discount rate is based on objectively verifiable capital markets data.

The CAPM establishes a theoretical link between risk and return for rational investors in information-efficient capital markets. Thus, this model is necessarily abstracted from reality and is only valid under restrictive conditions; empirical differences are to be expected for this reason alone. Despite empirical shortcomings, one reason for the dominance of the CAPM in practice is the lack of an alternative. The epistemological maxim of the Nobel Memorial Prize laureate in Economic Sciences, *George J. Stigler* is applicable: "*It takes a theory to beat a theory*"[1]. Even nearly 60 years after the initial development of the CAPM, no alternative method has been developed that is at least equally sound from a theoretical point of view and empirically superior.

Moreover, an economic theory cannot be verified. At most it can be falsified. To date, there has yet to be a successful *definitive* empirical falsification of the CAPM on the basis of statistical tests; indeed, such a final falsification is not to be expected when time series are used with (realized) ex-post returns instead of the (expected) ex-ante return parameters that the CAPM requires[2].

Furthermore, the CAPM has been continually refined and expanded since its introduction in the 1960s. Such expansions include global and international CAPMs, which take an international context into account. These extended versions of the original CAPM make it possible to capture the trend of growing globalization in the past few decades, as capital markets and markets for real goods have become increasingly integrated. However, the traditional version of the CAPM (standard, local or domestic CAPM), which remains popular in practice, operates on the assumption of complete market *isolation*, which prevents freedom of movement of goods or capital, rules out market-determined exchange rates and precludes any cross-border investment or goods trade. Since the collapse of the Bretton Woods system of fixed exchange rates and capital controls in the early 1970s, the assumption of complete isolation no longer reflects

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[1] *Stigler* Journal of Political Economy 1983, Nobel Lecture: The Process and Progress of Economics, pp. 529, 541. On the epistemological implications of econometric tests, see (for example) *Spanos* Statistical foundations of econometric modelling, 1986, p. 660: "[...], *however, to my knowledge no economic theory was ever abandoned because it was rejected by some econometric test, nor was a clear-cut decision between competing theories made in lieu of the evidence of such a test.*".

[2] *Black* Financial Analysts Journal 1993, Estimating Expected Return, p. 2: "*The key issue in investments is estimating expected return. It is neither explaining return nor* [...] *explaining average return.* [...], *the Capital Asset Pricing Model (CAPM) is a model of expected return.*".

the valuation-relevant conditions that investors face in relation to the capital markets of developed countries; the capital markets of developed countries are well-integrated and therefore global, and a flexible exchange rate mechanism prevails.

In addition, application of the CAPM (and the DCF method) depends on the assumption of rational investors. Rational investors fully exploit the given (cross-border) investment possibilities (diversification principle). Because the CAPM is based on the diversification principle, a market portfolio which comprises all risky investments in the integrated capital markets is the (only) valuation-relevant portfolio. In the regularly given international context of business valuation, the global CAPM (or the more complex international CAPM[3]) is the model that is consistent with the factual existence of well-integrated capital markets. Thus, valuation practitioners should use this version as the (new) standard CAPM model.

This note provides guidance on the application of the global CAPM in order to help valuation practitioners to adopt it. In particular, it provides an estimate of the global equity risk premium from a European perspective (Eurozone) based on the MSCI World Index (MSCI WI), a global market index that can be easily verified and actualized. In comparison to other estimates of the global equity risk premium that do not use a standard market index, the estimate based on the MSCI WI is consistent with the estimate of the global beta factor, as this time series can also be used directly in the regression analysis. Beyond discount rate estimates, the application of the (global) CAPM presupposes the application of a certain method for forecasting future exchange rates, i.e. the risk-adjusted forward rate method. Therefore, the global CAPM also provides a consistent exchange rate forecasting method.

In Section II of this note, the theoretical foundations of the global CAPM and the implied diversification principle are presented, and some questions regarding the use of the global CAPM are discussed. Section III provides an estimate of the global equity risk premium from a Eurozone perspective based on the MSCI WI as the global market portfolio as well as guidance for the estimation of the global beta factor and the relevant risk-free rate. Section IV presents the method implied by the global CAPM to estimate exchange rates (risk-adjusted forward rate method). Section V concludes.

II. Theoretical foundations

1. Global CAPM

The global CAPM from the perspective of Eurozone investors that consume in their home currency is specified as follows:

$$E\left[R_{j,G€}\right] = R_{f€} + MRP_{G€} \cdot \beta_{j,G€}. \qquad (1)$$

The expected return of stock j from the perspective of a Eurozone investor $E\left[R_{j,G}\right]$ depends on the risk-free interest rate R_f and a risk premium ($MRP_G \cdot \beta_{j,G}$). Here, the € sign is used to represent the home currency. The function of the risk-free rate is to reflect the "*price of immediate consumption*", whereas the function of the second term is to capture the "*price of risk reduction*"[4]. The risk premium represents the systematic risk that remains after considering a fully diversified investment portfolio. According to the assumptions of the traditional (local) CAPM used in practice, rational investors will take advantage of all available diversification opportunities. This principle also applies to the global CAPM, which assumes uniform consumption preferences and real goods prices in all countries that comprise integrated capital markets and real good markets[5].

The equity risk premium MRP_G (sometimes also referred to as the market risk premium[6]) is calculated as the difference between the expected return of the global market portfolio $E[R_G]$ and the risk-free interest rate R_f, thus $MRP_G = E[R_G] - R_f$. The beta factor $\beta_{j,G}$ of the global CAPM results from the returns of the stock; in this case, therefore, $\beta_{j,G} = Covariance\left[R_j; R_G\right] / Variance[R_G]$.

It is essential for valuation practitioners to understand that the global CAPM is based on a global market portfolio that represents all capital assets and financial securities available to rational investors that fully exploit the benefits of all possible international diversification. The expected returns and the systematic risk of a rational investor are the result of this

[3] See *Ejara/Krapl/O'Brien/Ruiz de Vargas* Journal of Investment Management 2020, Local, Global, and International CAPM: For Which Countries Does Model Choice Matter?, pp. 73-95.

[4] *Sharpe* Portfolio Theory and Capital Markets, 2000, p. 84.

[5] See a more detailed exposition in *Stulz* Journal of International Business Studies 1984, Pricing Capital Assets in an International Setting: An Introduction, pp. 55, 56; *Solnik/McLeavey* Global Investments, 6. ed. 2014, p. 139; *Bekaert/Hodrick* International Financial Management, 3. ed. 2018, p. 570; *Seiler Zimmermann/Zimmermann* Finance Compact Plus Band 2, 2021, p. 1004.

[6] This implies that the equity risk premium represents the market risk premium. For practical reasons, capital assets and financial securities are approximated with an equity market index, see also *Sharpe* Portfolio Theory and Capital Markets, 2000, pp. 143 ff. In *Stambaugh* Journal of Financial Economics 1982, On the Exclusion of Assets from Tests of the Two-Parameter Model: A Sensitivity Analysis, pp. 237 ff., it has been shown that the use of a stock market index is a reasonable assumption. See also *Levy/Roll* Review of Financial Studies 2010, The Market Portfolio May Be Mean/Variance Efficient After All: The Market Portfolio, pp. 2464 ff.

expanded global market portfolio. Portfolio weights of individual stocks are market-determined[7]. Accordingly, a global market portfolio, with all its globally available (risky) investment possibilities, represents the valuation-relevant investment universe for rational investors.

Consistent application of the global CAPM requires that the same market index is used to determine both the market risk premium and the regression analysis to determine the beta factor. Here, the MSCI WI represents a practitioner-friendly and useful market index for the investments in well-integrated capital markets of developed countries that (rational) investors in these countries can hold unhindered and at a very low cost (e.g. in ETF funds that track this market index).

2. Diversification Principle

In accordance with decision-theoretical dominance principles, preference is given to the return for which the lower risk is assumed, or to the higher return in the case of a given risk (mean-variance principle, M-V principle). The M-V principle applies to all readily available capital assets and financial securities of rational investors that intend to reap the advantages of a fully diversified portfolio (diversification principle). The diversification principle is a core element of the CAPM that is applicable to cross-border portfolios, i.e. portfolios that include risky investments in well-integrated capital markets. The following decision rule based on the Sharpe ratio using expected returns is applicable[8]:

$$\overbrace{\frac{E\left[R_{L€}\right]-R_{f€}}{\sigma_{L€}}}^{\text{Sharpe ratio foreign market (L)}} \cdot \overbrace{\frac{1}{\rho_{L,DE}}}^{\rho_{L,DE}\text{: correlation coefficient}} > \overbrace{\frac{E\left[R_{DE€}\right]-R_{f€}}{\sigma_{DE€}}}^{\text{Sharpe ratio domestic market (DE)}} \cdot \qquad (2)$$

According to this diversification rule, investment in a foreign market portfolio is advantageous even if both Sharpe ratios are identical, as long as the two markets do not correlate perfectly. The lower the correlation between the domestic market and the foreign market, the higher the diversification benefit is for the (rational) investor.

A major stock market within the Eurozone such as the German stock market, which comprises only a small fraction of the global market portfolio, presents more diversification opportunities than the US market portfolio, which constitutes more than half of the global market portfolio on average[9]. This implies that the deviation from the diversification principle of the CAPM is more pronounced in developed countries outside the US. The capital market integration of developed economies also implies that the markets tend to have a stronger correlation and the diversification benefit tend to decay for these investors, but not to the extent that a domestic portfolio investment strategy clearly dominates ex ante a global market portfolio investment strategy. Empirically, even well-integrated capital markets still provide sufficient diversification benefits[10].

3. Practitioner's questions

To better understand the application of the global CAPM it is useful to discuss some questions regarding the use of the global CAPM in practice that are occasionally brought forward.

a) Irrelevance proposition

The irrelevance proposition questions the use of the global CAPM because it supposedly delivers the same risk premia as the local CAPM. As a consequence practitioners should not make the effort to change the traditional approach based on the local CAPM, as no different price of risk would result.

Conceptually, the irrelevance proposition is in general not compatible with the theoretical framework of

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[7] Equal weighting does not deliver efficient portfolios and therefore would not be compatible with the CAPM, see *Sharpe* Portfolio Theory and Capital Markets, 2000, pp. 82 ff., 94 ff., 183 f.; *Levy* The Capital Asset Pricing Model in the 21st Century: Analytical, Empirical, and Behavioral Perspectives, 2012, pp. 123 ff.

[8] See *Bekaert/Hodrick* International Financial Management, 2018, p. 555; *Elton/Gruber/Brown/Goetzmann* Modern Portfolio Theory and Investment Analysis, 9. ed. 2014, pp. 270 f. Variables: $E[R_{L€}]$ or $E[R_{DE€}]$: return of the foreign (L) or domestic stocks (DE) in euro; $R_{f€}$: risk-free rate for a European investor in euro; $\rho_{L,DE}$: correlation coefficient for the returns of the foreign market index and the return of the domestic market index (both in euro); $\sigma_{L€}$ or $\sigma_{DE€}$: standard deviation of the corresponding returns.

[9] *Asness/Ilmanen/Villalon* Journal of Portfolio Management 2023, International Diversification - Still Not Crazy after All These Years, pp. 9-18; *Attig/Sy* Financial Analysts Journal 2023, Diversification during Hard Times, pp. 45-64; *Mukherji/Jeong* Global Finance Journal 2021, Long-term international diversification of equities, pp. 100584-100655. See for a more detailed analysis with additional literature references *Ruiz de Vargas* BWP 2022, Globales CAPM: Schätzung der globalen Marktrisikoprämie, pp. 73 ff.

[10] In *Dimson/Marsh/Staunton* Credit Suisse Global Investment Returns Yearbook 2022, 2022, pp. 104 ff., an ex post-analysis is presented (p. 106: "*Our estimates suggest that global investors in most DMs* [developed markets] *can now expect a more modest, but still useful level of risk reduction from global diversification*.").

the CAPM. As has been pointed out in the finance literature in relation to the application of the CAPM, the risk and return profile of a security is defined by the portfolio used as the reference portfolio[11]. It follows that different portfolios, i.e. global vs. local portfolios, should *generally* provide different systematic risks and different expected returns for a specific security. This implies that the irrelevance proposition cannot support the use of the local CAPM. For practical applications, it is therefore indispensable to analyze the difference between the local and global CAPM at a *firm level* before embracing the irrelevance proposition. Differences are to be expected because different equity risk premia and beta factors will result when the risk premium of the global CAPM is compared to the local CAPM (see Section III below).

Of course, this does not entail that, for whatever reason, empirically speaking, the differences in the risk premium for a particular security can be economically insignificant when the two versions of the CAPM are compared in some specific cases. However, generalizing this finding is conceptually problematic. In addition, it has been shown empirically, that, from a European perspective, substantial differences between the local and the global CAPM need to be considered *at the firm level*[12]. This leads to the conclusion that the irrelevance proposition lacks conceptual and empirical support (at the firm level).

b) Equity home bias (EHB)

Some practitioners object that the application of the global or international CAPM is questionable or should even be rejected due to the so-called "equity home bias" (EHB). The EHB refers to the empirical observation that the portfolios of market participants tend to be characterized by an overweight of home-country equities, which is not consistent with the portfolio weights in the global market portfolio. According to these practitioners, the EHB supports the use of the local CAPM instead of the global CAPM.

The prevalent explanation for the EHB that is provided in the literature is based on *irrational* behavior (ex post)[13]. The EHB is therefore an empirical anomaly that violates essential conditions of not only the global but also the local CAPM: the diversification principle and the rational investor assumption[14]. Thus, the EHB is inconsistent with the CAPM in general, so neither the local nor the global CAPM can be applied. The EHB cannot support the use of the local CAPM instead of the global CAPM and does not provide a theoretically sound alternative risk-return model.

The EHB represents an empirical anomaly for realized portfolio weights (ex post view). However, a valuation model based on the CAPM aims to mirror the *ex ante* decision of a rational investor, even though, in the real world, it seems ex post that not all market participants act rationally[15]. The CAPM is about *expected* returns of a rational investor not about *realized* returns[16]. Given sufficiently globally integrated capital markets, rational investors derive their expectations from a fully diversified market portfolio encompassing all available capital assets and financial securities. Here, the EHB is conceptually irrelevant, because the theorem that the average investor must hold the market portfolio[17] is to be observed ("*If some investors hold too much of a certain stock, but others hold too little of it, market valuations are unaffected and the advice to hold the market portfolio is still valid.*"[18]).

Moreover, the accurate measurement of the EHB is

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[11] *Fama* Foundations of Finance, 1976, pp. 60, 242: "*First, to be precise, one must always talk about risk of security i in portfolio p, since the risk of a security is different from one portfolio to another.*" *Ross* Journal of Finance 1978, The Current Status of the Capital Asset Pricing Model (CAPM), pp. 885, 886: "*Since in aggregate all risk is borne by the market portfolio, only the relationship between the asset and the market portfolio, its beta, can determine the premium for an individual asset.*".

[12] *Stulz* Journal of Applied Corporate Finance 1995, Globalization of capital markets and the cost of capital: The case of Nestlé, p. 30: "*The differences between cost of capital and share valuations produced by the two models* [global vs. local CAPM; explanation added] *are potentially quite large.*". For the German firms of the DAX Index see *Ruiz de Vargas/Breuer* BWP 2015, Unternehmensbewertung im internationalen Kontext mit dem globalen CAPM (Teil 2), pp. 50 ff. See also *Ejara/Krapl/O'Brien/Ruiz de Vargas* Journal of Investment Management 2020, Local, Global, and International CAPM: For Which Countries Does Model Choice Matter?, pp. 73 ff. Here however, no results at the firm level are presented.

[13] *Gaar/Scherer/Schiereck* Management Review Quarterly 2022, The home bias and the local bias: A survey, pp. 21, 49: "*Investors do not diversify according to standard CAPM.*" Alternative explanations for the EHB instead of irrational market participants cannot support the use of the local CAPM. If any other explanations would lead to the consideration of more complex versions of the CAPM that capture partial integration aspects that may explain the different portfolio weights, see footnote 25.

[14] From an empirical perspective, it has also been documented that, in a domestic capital market (some or many) local market participants favor an overweight of their employer's stock or the stock of companies in the home city or region ("local bias"); see, for example, *Coval/Moskowitz* Journal of Finance 1999, Home Bias at Home: Local Equity Preference in Domestic Portfolios, pp. 2045 ff.; *Gaar/Scherer/Schiereck* Management Review Quarterly 2022, The home bias and the local bias: A survey, pp. 22, 27.

[15] *Gaar/Scherer/Schiereck* Management Review Quarterly 2022, The home bias and the local bias: A survey, p. 21: "*In a frictionless perfect global capital market, investors should invest the risky part of their savings completely in the market portfolio to optimize their risk-return patterns and to comply with classical approaches as the CAPM.*".

[16] See footnote 2.

[17] *Cochrane* (2011), Presidential Address: Discount Rates, Journal of Finance 66 (4), pp. 1047, 1081.

[18] *Cochrane* (1999), Portfolio Advice of a Multifactor World, Economic Perspectives 23 (3), pp. 59, 62. *Cochrane* (2014), A Mean-Variance Benchmark for Intertemporal Portfolio Theory, Journal of Finance 69 (1), pp. 1, 4: "*Portfolio theory seems to apply to everyone. But the average investor must hold the market portfolio, and consume from the market payoff, ignoring all tempting dynamics or additional factors. All*

plagued with empirical difficulties[19]. Any assertions regarding market participants' portfolio composition are therefore fraught with substantial uncertainty[20]. In addition, increasing globalization in recent decades has considerably diminished the empirical importance of the EHB, so that this objection must also be put into perspective empirically ("*a general decline in home bias in the course of time*"[21]). Furthermore, the EHB focuses on portfolio weights and not on return behavior ("[...] *the literature that investigates returns of securities across countries finds that most assets are priced as if markets are internationally integrated over the recent past.*"[22]).

In addition, investors in developed countries have unrestricted access to low-cost funds (e.g. ETF funds) that reflect well-integrated capital markets and are accessible for all investors in these countries. Within the European Union, practitioners must take into account that rational ex ante expectations consider that a European Banking Union and a capital markets union - beyond the current very advanced integration - is to be implemented. In relation to third countries, a full liberalization principle also applies (Art. 63 para. 1 TFEU, ex Art. 56 TEC: "*Within the framework of the provisions set out in this Chapter, all restrictions on the movement of capital between Member States and between Member States and third countries shall be prohibited.*"). In essence there are no valuation-relevant impediments to assuming that the capital markets of developed countries are not sufficiently integrated for rational investors from a European perspective[23].

It is paramount to realize that the return expectations of *irrational* market participants cannot be modelled by the local, global or international CAPM. Therefore, it is contradictory to invoke the EHB as a reason to apply the local CAPM instead of the global (or international) CAPM. The EHB is not sufficient to justify a choice between the local and the global CAPM. In a given international context, the global CAPM is still conceptually preferable to the local CAPM, as it fulfills the consistency condition for business valuations in well-integrated capital markets.

c) Country risk premium

The global CAPM is a single-factor model. Some practitioners reject the global CAPM because they believe it lacks an additional country risk premium that should allegedly represent the new risk incurred by a cross-border investment. However, they provide neither a theoretically sound model incorporating this additional risk premium into the CAPM nor any empirical support.

From a conceptual perspective, practitioners should be aware that the ad hoc application of additive, multiplicative, or otherwise interlinked country risk premia lacks the required theoretical support and is therefore not compatible with the (global) CAPM[24]. Thus, using an additional country risk premium implies that practitioners cannot assert having applied the CAPM consistently. In addition there are - to my knowledge - no valid empirical studies that test the returns calculated with the use of such additional country risk premia and compare their return prediction accuracy to the global or international CAPM. Consequently, these ad hoc approaches lack any *empirical* support.

The mere methodologically unfounded "intuition" of some valuation practitioners to the effect that a higher - sometimes exorbitantly higher - risk premium must "somehow" be applied in a cross-border valuation, has little in common with a consistent, theoretically sound and intersubjectively verifiable business valuation. This intuition constitutes neither a necessary nor a sufficient condition to support the application of an additional country risk premium when applying otherwise the CAPM in an international context.

In essence, all these ad hoc approaches attempt to solve the problem of partially integrated capital mar-

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deviations from market weights are a zero-sum game.".

[19] See for example *Molestina Vivar/Lambert/Wedow/Giuzio* ECB-Report, Financial Integration and Structure in the Euro Area 2020, Is the home bias biased? New evidence from the investment fund sector, pp. 122, 126: "*When taking into account investors' countries of origin we find a lower home bias throughout the euro area, compared with home bias measures that use the fund domicile as investment origin*". *Gaar/Scherer/Schiereck* Management Review Quarterly 2022, The home bias and the local bias: A survey, pp. 27 ff., 30: "*The consistency and accuracy of data and measurements is only guaranteed within one specific study and within one specific method of measurement*.".

[20] See *Gaar/Scherer/Schiereck* Management Review Quarterly 2022, The home bias and the local bias: A survey, pp. 21, 49: "*Though, since there is no unified approach of how to measure the extent of home bias, the results vary notably, especially across countries. No final conclusion on the relation between country and extent can be made*.".

[21] *Gaar/Scherer/Schiereck* Management Review Quarterly 2022, The home bias and the local bias: A survey, pp. 21, 49: "*However, the degree varies across time and country. The degree has been decreasing, mainly due to relaxing capital controls and by eliminating explicit barriers (transaction costs) to foreign investments*.". See also *Ruiz de Vargas/Breuer* BWP 2015, Unternehmensbewertung im internationalen Kontext mit dem globalen CAPM (Teil 1), pp. 2, 8, with further references.

[22] *Stulz* European Financial Management 1995, The cost of capital in internationally integrated markets: The case of Nestlé, pp. 11, 18: "[...] *it is perfectly possible for the global CAPM to hold even though nobody holds exactly the global market portfolio*.".

[23] *Stulz* Journal of Applied Corporate Finance 1999, Globalization, Corporate Finance, and the Cost of Capital, pp. 8, 19: "[...] *once that security begins to trade in a relatively open market, the global CAPM becomes the relevant pricing model*.".

[24] For a detailed critique of the Damodaran approach, see *Kruschwitz/Löffler/Mandl* WPg 2011, Damodarans Country Risk Premium - und was davon zu halten ist, pp. 167 ff.; *Kruschwitz/Löffler/Mandl* BVR 2012, Damodaran's Country Risk Premium: A Serious Critique, pp. 75 ff. See also the evaluation in *Breuer/Ruiz de Vargas* Journal of Business Economics, Special Issue International Financial Management and Valuation 2021, Some Key Developments in International Financial Management, pp. 595, 608 ff.

kets. For this purpose, however, theoretically sound extended versions of the CAPM are to be preferred for reasons of consistency and objectivity[25]. Admittedly, these models involve a higher degree of complexity. However, the avoidance of this additional complexity provides no justification for the use of largely arbitrary approaches lacking any theoretical or empirical basis. On the contrary, the additional complexity of the extended versions of the CAPM for partially integrated capital markets proves that the simple approach with an ad hoc country risk premium is not suitable for solving the problem of determining the systematic risk in the context of largely segmented capital markets.

When applying the CAPM, moreover, a distinction should always be made between systematic non-diversifiable risks and unsystematic diversifiable risks. Concrete diversifiable country risks that could affect cash flows from the foreign country (e.g. expropriation) should be accounted for by devising scenarios and weighting them in multi-year business plans at the level of the valuation-relevant cash flows in the *numerator* of the valuation model with their expected probability. Ad hoc adjustments for country risk in the *denominator* of the valuation model are then superfluous.

III. Estimating the parameters of the global CAPM

1. Risk-free rate

The (nominal) risk-free rate for the global CAPM corresponds to the risk-free rate of the local CAPM[26]. The nominal risk-free rates of different integrated capital markets are related via (risk-adjusted) uncovered interest rate parity (see Section IV). For European investors that consume in euro, the sovereign debt within the European Monetary Union with the lowest risk and sufficient liquidity provides the best estimate for the risk-free rate. This is currently German government debt. It is important to note that the risk-free rate for the global CAPM is the home currency risk-free rate for a particular investor and not an average of all the risk-free rates derived from different countries.

Since a multiperiod context is used in practical valuation applications based on the unconditional CAPM, and yearly cash flows over indefinite planning periods (detailed planning period phase, convergence phase and terminal value phase) are usually discounted, government debt with long-term maturity should be used[27]. For consistency, the interest rates along the zero-coupon yield curve are preferable (term structure equivalence principle)[28]. The method developed by Svensson, which represents an extended version of the Nelson and Siegel method, is usually applied by central banks (NSS method)[29] and particularly suitable for practical business valuations. The NSS data provided by the Deutsche Bundesbank on its website for German government debt can be used to estimate the zero-coupon yield curve up to a maturity of 30 years. From the zero-coupon yield curve a constant estimate of a one-year equivalent interest rate can be obtained with a present value calculation. This calculation equates the periodic-specific interest rates along the yield curve and an equivalent constant interest rate.

No market-determined interest rates are available for periods of more than 30 years ahead. As a simplification, the interest rate of the last maturity year of the

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[25] See for example *Merton* Journal of Finance 1987, A Simple Model of Capital Market Equilibrium with Incomplete Information, pp. 483 ff.; *O'Brien* Managerial Finance 2020, Applying Merton's Valuation Adjustment For Incomplete Information ... And Do You Need To?, pp. 109 ff.; *Alexander/Eun/Janakiramanan* Journal of Finance 1987, Asset Pricing and Dual Listing on Foreign Capital Markets: A Note, pp. 151 ff.; *Eun/Janakiramanan* Journal of Finance 1986, A Model of International Asset Pricing with a Constraint on the Foreign Equity Ownership, pp. 897 ff.; *Black* Journal of Financial Economics 1974, International capital market equilibrium with investment barriers, pp. 337 ff.; *Stulz* Journal of Finance 1981, On the Effects of Barriers to International Investment, pp. 923 ff.; *Errunza/Losq* Journal of Finance 1985, International Asset Pricing under Mild Segmentation: Theory and Test, pp. 105 ff.; *Bekaert/Harvey* Journal of Finance 1995, Time-Varying World Market Integration, pp. 403 ff.; *Cooper/Kaplanis* Journal of International Money and Finance 2000, Partially segmented international capital markets and international capital budgeting, pp. 309 ff.; *Uppal* Journal of Finance 1993, A General Equilibrium Model of International Portfolio Choice, pp. 529 ff.; *Chaieb/Errunza* Journal of Financial Economics 2007, International Asset Pricing under Segmentation and PPP Deviations, pp. 543 ff.

[26] *Stulz* Journal of Applied Corporate Finance 1995, Globalization of capital markets and the cost of capital: The case of Nestlé, pp. 30, 36: "R_f *is still the local country risk-free rate*.".

[27] See for example *Armitage* The Cost of Capital: Intermediate Theory, 2005, pp. 278-281. For the conditions in relation to the use of the CAPM in a multiperiod context see *Fama* Journal of Financial Economics 1977, Risk-Adjusted Discount Rates and Capital Budgeting under Uncertainty, pp. 3 ff.; *Haley/Schall* The Theory of Financial Decisions, 2. ed. 1979, pp. 189 ff. *Copeland/Weston* Financial Theory and Corporate Policy, 3. ed. 2003, pp. 402 ff.

[28] See *Schwetzler* ZfB 1996, Zinsänderungsrisiko und Unternehmensbewertung: Das Basiszinsfuß-Problem bei der Ertragswertermittlung, pp. 1081 ff.; *Gebhardt/Daske* WPg 2005, Kapitalmarktorientierte Bestimmung von risikofreien Zinssätzen für die Unternehmensbewertung, pp. 649 ff. Note that in an arbitrage-free bond market, the yield curve, the discount curve and the forward rate curve are equivalent, see *Diebold/Rudebusch* Yield Curve Modeling and Forecasting, 2013, pp. 2 ff., 16 ff.

[29] *Bank for International Settlements* Zero-Coupon Yield Curves: Technical Documentation, 2005, BIS Papers, Nr. 25; *Nelson/Siegel* Journal of Business 1987, Parsimonious Modeling of Yield Curves, pp. 473 ff.; *Svensson* Sveriges Riksbank Quarterly Review 1995, Estimating Forward Interest Rates with the Extended Nelson & Siegel Method, pp. 13 ff.; *Nawalkha/Soto* Alternative Investment Analyst Review 2017, A Review of Term Structure Estimation Methods, pp. 67 ff. See *Drukarczyk/Schüler* Unternehmensbewertung, 8. ed. 2021, pp. 246 ff., for a practitioner friendly exposition.

yield curve (30-year rate) is extrapolated for the terminal value calculation [30].

2. Global equity risk premium

a) Estimating the global risk premium from a euro perspective

While estimates of the domestic equity risk premium are usually readily available, estimates of the global equity risk premium for developed markets are scarce. Using the "historical approach" (long-run historic average of realized returns) requires a long-time series for global market returns and local interest rates. If certain statistical conditions hold (in particular stationarity) the arithmetical mean provides a reasonably good estimate for the future equity risk premium to be applied in the unconditional CAPM version. *Fama* and *French* point out that the stationarity assumption for an unconditional equity risk premium may be regime-dependent [31].

While long-time series reduce the standard error of the mean estimate, they are more heavily affected by economic regime changes. The post-Bretton Woods system (1970 to 2021), with flexible exchange rates and without capital controls between the developed markets, is the valuation-relevant framework for current valuations.

Using the time series of yearly returns (1970-2021) for the MSCI WI as the global market index, converting these returns into euro with the EUR/USD (1999-2021) and ECU/USD (1970-1998) exchange rates and the corresponding end-of-period risk-free rate based on German sovereign debt (NSS method) results in an estimate of 6.0% (arithmetic mean) for the global equity risk premium from the perspective of an investor that consumes in euro. The estimate after considering a definitive personal income tax from dividends of 25% and on deferred capital gains of 12.5% is about 5.0% [32].

b) Unconditional equity risk premium

The version of the global CAPM presented in Equation (1) complies with the *unconditional* CAPM, the version used in most practical applications. This implies the assumption of a constant market risk premium and a constant beta factor. Hence, it is inconsistent to use a time-dependent market risk premium and assume time-dependent beta factors when applying the *unconditional* CAPM with constant parameters [33].

Nevertheless, capital market research suggests that the market or equity risk premium is time-dependent, and therefore the use of the historical approach might be questionable. However, time-dependency relates to temporary effects and is a general challenge for all models. It may explain their poor empirical performance [34]. Some valuation practitioners prefer the "implied equity risk premium" derived from financial analysts' expectations. However, the assumed empirical superiority of the implied equity risk premium estimates in comparison to a simple historical average has yet to be demonstrated, since to my knowledge no empirical study supports this claim. Furthermore, this approach has its own estimation flaws [35]. The theoretical consistency of this estimation approach with the *conditional* version of the CAPM is not to be assumed since the additional risk parameters of the conditional CAPM are not contemplated.

From a valuation perspective, practitioners should be aware that it is inconsistent to plug time-dependent estimates of an equity risk premium into the *unconditional* version of the CAPM. An equity risk premium and a beta factor that are deemed to be time-dependent are not compatible with the unconditional

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[30] See *Kruschwitz* ZfbF 2018, Das Problem der Anschlussverzinsung, pp. 9-45.

[31] See *Fama/French* Journal of Finance 2002, The Equity Premium, pp. 637, 638. The author thanks them for providing the appendix to their paper 20 years after publication!

[32] For more details, see the empirical analysis in *Ruiz de Vargas* BWP 2022, Globales CAPM: Schätzung der globalen Marktrisikoprämie, pp. 73 ff. Some practitioners may consider an estimate based on 52 years and a standard error of 2.7% for the (global) equity risk premium too short a time series for a forecast. However, a more precise estimate with, for example, a standard error of 0.5% for a risk premium, and a standard deviation of 15% would require 900 years of data, see also *Booth* Journal of Applied Corporate Finance 2019, Estimating the Equity Risk Premium and Expected Equity Rates of Return: The Case of Canada, pp. 113 ff. It follows that even studies that are based on time series spanning over 100 years are fraught with great uncertainty even as they are biased because of economic systems that are not to be expected in the future (in particular a gold standard, capital controls, two world wars, fixed exchange rates).

[33] The conditional version of the CAPM is applicable to time-dependent risk premia, see *Jagannathan/Wang* Journal of Finance 1996, The Conditional CAPM and the Cross-Section of Expected Returns, pp. 3, 9; *Lewellen/Nagel* Journal of Financial Economics 2006, The Conditional CAPM Does Not Explain Asset-Pricing Anomalies, pp. 289, 293.

[34] See *Welch/Goyal* Review of Financial Studies 2008, A comprehensive look at the empirical performance of equity premium prediction, pp. 639 ff. See also *Cochrane* Review of Finance 2017, Macro-Finance, pp. 945 ff. and the literature cited therein. *Merton* Journal of Financial Economics 1980, On estimating the expected return on the market: An exploratory investigation, pp. 323 ff., indicates that this may be due to time-varying variance of returns or risk aversion.

[35] For an overview of different versions of these models, see for example *Duarte/Rosa* Economic Policy Review 2015, The Equity Risk Premium: A Review of Models, pp. 39 ff. Sometimes the term "forward-looking equity risk premium" is used. However, this is misleading, since all methods try to estimate a forward-looking equity risk premium. *Echterling/Eierle/Ketterer* International Review of Financial Analysis 2015, A Review of the Literature on Methods of Computing the Implied Cost of Capital, pp. 235 ff., present a comprehensive and critical review of these models.

CAPM and require the use of the *conditional* CAPM with additional parameters that must be estimated[36]. Ignoring these additional parameters may lead to erroneous valuation results.

While the historical approach may be the simplest approach, it provides at least a consistent estimate for the *unconditional* CAPM if the stationarity premise holds[37].

c) Relationship between local and global equity risk premium

The local equity risk premium of a particular country (L) can be higher or lower than the global equity risk premium (G). The relationship between the local and global CAPMs can be described as follows:

$$\begin{aligned} &E\left[R_{L,G€}\right] = R_{f€} + MRP_{G€} \cdot \beta_{L,G€}. \\ &\overbrace{E\left[R_{L,G€}\right] - R_{f€}}^{MRP_{L€}} = MRP_{G€} \cdot \beta_{L,G€} \\ &MRP_{L€} = MRP_{G€} \cdot \beta_{L,G€}. \end{aligned} \quad (3)$$

The expected return of a local market portfolio ($E[R_{L,G}]$) can be derived directly from the global CAPM (first line). The relationship between the two market-risk premia is indicated in the final line of Equation (3). Thus, the local equity risk premium (MRP_L) depends on the global beta factor, which describes the systematic risk of the domestic market portfolio within the global market portfolio ($\beta_{L,G}$).

Equation (3) refutes the "intuition" sometimes encountered in valuation practice to the effect that an international diversification implies a global equity risk premium (MRP_G) that must always be less than the local equity risk premium (MRP_L). Because a global market portfolio must have a beta factor of one, there are beta factors of domestic market portfolios that must be both higher than and lower than one. It follows that the resulting local equity risk premium of a particular country can be higher or lower than the global equity risk premium.

3. Global beta factor

The CAPM requires that the market portfolio that is used for the equity risk premium is also applied in the regression analysis to obtain the beta factor. Using the MSCI WI for the global equity market risk premium fulfills this consistency condition, as this time series is also available to estimate the beta factor of a quoted firm.

However, sometimes the stock of the firm that is to be valued is not publicly traded. In this case the beta factor is derived from a peer group of firms that are publicly quoted. In such a case, practitioners should be aware that it is inconsistent to use different market indices for the firms within this peer group. From the perspective of an investor, only one market portfolio can represent the valuation-relevant market portfolio when using the CAPM. This is the local market portfolio when the capital market is isolated from the rest of the world, but, in the case of well-integrated capital markets, only the global market portfolio can reflect the relevant systematic risk and expected return. The following equation shows that the global beta factor is composed of two components that capture different aspects of the *diversification effect*[38].

$$\beta_{j,G€} = \beta_{j,L€} \cdot \beta_{L,G€} + \frac{Covariance\left[\varepsilon_{j,L€}, R_{G€}\right]}{Variance\left[R_{G€}\right]}. \quad (4)$$

The first term in Equation (4) shows that the local beta factor $\beta_{j,L€}$ must be adjusted by the systematic risk of the local market portfolio in relation to the global market portfolio ($\beta_{L,G€}$). Depending on the correlation, the result of the first term is higher or lower than the local beta. The second term shows the part of the return of stock j that is uncorrelated to the local market portfolio but not to the global market portfolio if the covariance term is not zero. Fully diversified rational investors reward this covariance risk if it is positive or expect a discount if it is negative. Equation (4) demonstrates the valuation error caused by the diversification effect and made by a practitioner that uses the beta factor derived from a local market portfolio ($\beta_{j,L€}$) instead of the global beta factor ($\beta_{j,G€}$).

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[36] See footnote 33.

[37] For the estimate of the global equity risk premium presented above the null hypothesis of no stationarity can be strongly rejected based on the Augmented Dickey-Fuller test and the Phillips-Perron test. The null hypothesis of stationarity cannot be rejected on the basis of the Kwiatkowski-Phillips-Schmidt-Shin test.

[38] See *Stulz* European Financial Management 1995, The cost of capital in internationally integrated markets: The case of Nestlé, pp. 11, 15; *Ruiz de Vargas/Breuer* in *Tönnes* Unternehmensbewertung, FS Großfeld, 2019, pp. 355, 372. Here $\varepsilon_{j,L}$ is the residuum in the regression equation for the local CAPM (all in euro) in relation to the return of stock j: $R_j = \alpha_{j,L} + \beta_{j,L} \cdot R_L + \varepsilon_{j,L}$. The equation for the return of the local market portfolio is $R_L = \alpha_{L,G} + \beta_{L,G} \cdot R_G + \varepsilon_{L,G}$. It follows that $R_j = \alpha_{j,L} + \beta_{j,L} \cdot (\alpha_{L,G} + \beta_{L,G} \cdot R_G + \varepsilon_{L,G}) + \varepsilon_{j,L}$. Since the global beta factor is defined as $\beta_{j,G} = Covariance[R_j; R_G]/Variance[R_G]$, after some rearranging, introducing this equation for R_j results in Equation (4). It is important to note that, in a linear regression, the covariance of the residuum with the regressor is zero per assumption, i.e. $Covariance[\varepsilon_{L,G}; R_G] = 0$, see *Brooks* Introductory Econometrics for Finance, 4. ed. 2019, p. 107.

The currency equivalence principle requires cash flows and discount rates to be defined in the same currency. If some or all of the firms of the peer group are quoted in foreign stock exchanges and in foreign currencies, the returns are to be converted into euros. With the following decomposition of the local beta factor ($\beta_{j,L€}$) in Equation (4) the *currency conversion effect* can be highlighted[39]:

$$\underbrace{\beta_{j,L€(FC)}}_{\text{Local beta in euro}} = \frac{\text{Covariance}\left[R_{j,€(FC)}, R_{L€(FC)}\right]}{\text{Variance}\left[R_{L€(FC)}\right]} = \frac{\text{Cov}\left[R_{j,FC} + X_{€/FC} + R_{j,FC} \cdot X_{€/FC}, R_{L,FC} + X_{€/FC} + R_{L,FC} \cdot X_{€/FC}\right]}{\text{Var}\left[R_{L,FC} + X_{€/FC} + R_{L,FC} \cdot X_{€/FC}\right]}$$

$$= \frac{\text{Cov}\left[R_{j,FC}, R_{L,FC}\right] + \text{Cov}\left[R_{j,FC}, X_{€/FC}\right] + \text{Cov}\left[X_{€/FC}, R_{L,FC}\right] + \text{Var}\left[X_{€/FC}\right]}{\text{Var}\left[R_{L,FC}\right] + \text{Var}\left[X_{€/FC}\right] + 2 \cdot \text{Cov}\left[R_{L,FC}, X_{€/FC}\right]} \tag{5}$$

$$\neq \underbrace{\frac{\text{Covariance}\left[R_{j,FC}, R_{L,FC}\right]}{\text{Variance}\left[R_{L,FC}\right]}}_{\text{Local beta in FC}} = \beta_{j,L,FC}.$$

The second line in Equation (5) shows that the local beta factor of firm *j* that is quoted in a foreign currency has several components in the nominator and in the denominator that depend on the exchange rate. As these exchange rate driven components are usually different from zero the local beta factor in the foreign currency will deviate from the local beta factor in the home currency (€). Therefore, the additional components in the second line in Equation (5) represent the estimation error that a valuation practitioner makes if the currency conversion is omitted.

It follows that the use of the local beta factor for a stock that is quoted in a foreign currency instead of the global beta factor in euro implies two errors (diversification effect and currency conversion effect) that may significantly distort the resulting value of the firm.

IV. Relationship between the CAPM and the exchange rate forecasting method

A basic valuation principle relevant to the DCF method and the CAPM is the principle of arbitrage-efficient and speculation-efficient capital markets. Whereas the assumption of *arbitrage efficiency* excludes the generation of risk-free arbitrage profits ("no free lunch"), the assumption of *speculation efficiency* implies that the expected value of speculative investment positions is always zero *ex ante*. This means that it is not to be expected *ex ante* that an individual investor (or investment manager) can systematically outperform the market on the basis of publicly available information ("you can't beat the market"). Thus, when a capital market-based valuation method such as the CAPM is used, the assumption of arbitrage-efficient and speculation-efficient capital markets applies to the determination of the business value, which rules out value distortions based on the approach of risk-free arbitrage profits or systematic speculation profits.

When the global and international CAPMs were developed, it was recognized that a conceptual relationship exists between the CAPM and the exchange rate forecasting method. This reveals another theoretical strength of the CAPM: this model for determining a capital markets-oriented risk premium for the discount rate also offers a market-based forecasting method. On the basis of the global CAPM, the relationship representing the CAPM-compatible exchange rate forecasting method can be described as follows (see appendix for a derivation of this equation):

$$E\left[S_{€/FC,t+1}\right] = F_{€/FC,t,t+1}\left(1 + \frac{MRP_G \cdot \beta_{X,G}}{\left(1 + R_{f€}\right)}\right). \tag{6}$$

The forecast of the expected spot exchange rate $E\left[S_{€/FC,t+1}\right]$ in Period $t+1$ appears on the left side of Equation (6). The forward exchange rate ($F_{€/FC,t,t+1}$) in Period t with a currency exchange agreed for this exchange rate in Period $t+1$ on the

[39] See *Ruiz de Vargas/Breuer* in *Tönnes* Unternehmensbewertung, FS Großfeld 2019, pp. 355, 370. The return of stock j that is quoted in a foreign currency (FC) in euro is: $R_{j,€(FC)} = R_{j,FC} + X_{€/FC} + R_{j,FC} \cdot X_{€/FC}$; for the market portfolio: $R_{G,€(FC)} = R_{G,FC} + X_{€/FC} + R_{G,FC} \cdot X_{€/FC}$. To derive the second line in Equation (5) it is assumed that the second order terms are small: $R_{j,FC} \cdot X_{€/FC} \approx 0$; $R_{G,FC} \cdot X_{€/FC} \approx 0$.

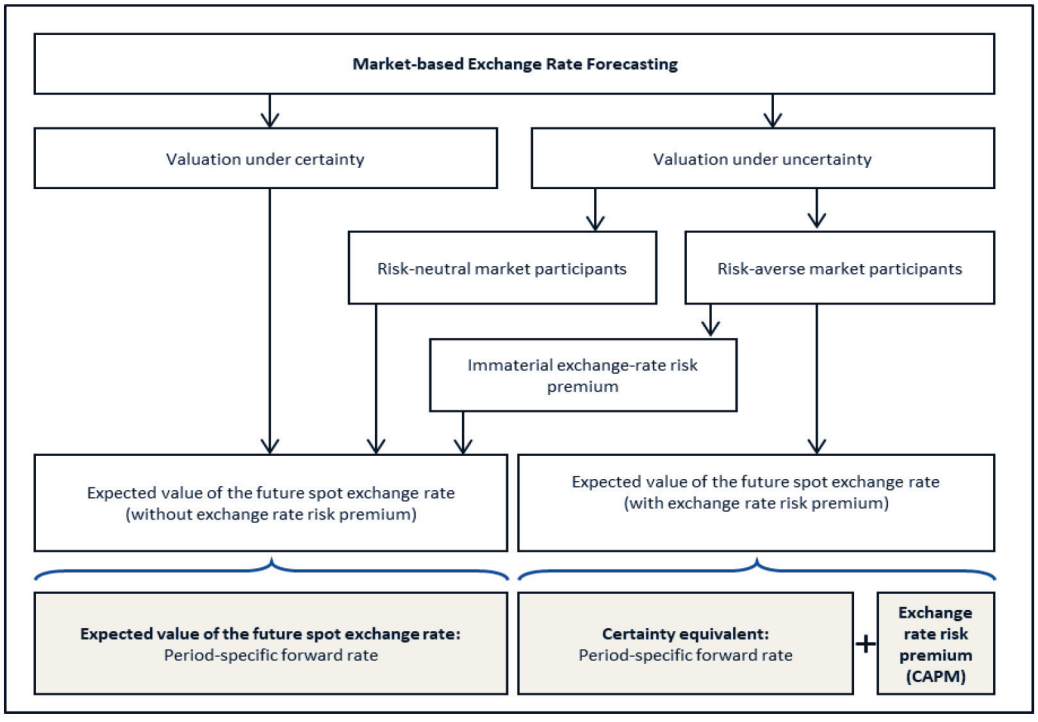
right side represents the certainty equivalent of the future spot exchange rate.

Practitioners should be aware that applying the CAPM in an international context automatically predetermines the forecasting method to be used to predict future expected exchange rates. There are two general cases: First, assuming *certainty*, the forward exchange rate directly represents the future (expected) spot exchange rate. This implies that the second term (beta factor of the exchange rate) in Equation (6) is zero. Second, assuming *uncertainty*, the forward exchange rate, i.e. the first term in Equation (6), represents the certainty equivalent. Then an additional risk premium is required to obtain the expected value of the spot exchange rate. The exchange rate forecasting decision in a capital markets-oriented valuation model is summarized in Figure 1 below[40].

When the CAPM is applied, risk aversion and uncertainty is assumed. In this case, the future certainty equivalent of the future exchange rate (i.e. the forward rate) must be adjusted by the CAPM-based risk premium, i.e. the second term in Equation (6), $MRP_G \cdot \beta_{X,G} / \left(1 + R_{f€,t+1}\right)$. The sum of the certainty equivalent and the CAPM-based risk premium reflects the expected future spot exchange rate. Thus, Equation (6) represents the *risk-adjusted forward rate method* on the basis of the global CAPM and should be applied using a roll-back approach.

The exchange rate-dependent risk premium included in Equation (6) can be either positive or negative, depending on the sign of the beta factor that reflects the systematic exchange rate risk of the currency in relation to the global market portfolio from the perspective of the reference currency ($\beta_{X,G} = Covariance\left[X_{€/FC}; R_G\right] / Variance[R_G]$). If this beta factor is close to zero, it is not necessary to account for the CAPM-based risk premium (see Figure 1). In such a case, the currency conversion effect related to the second term in Equation (6), i.e. the general systematic exchange risk, can also be eliminated.

Figure 1. Exchange rate forecasting using a market-based approach



Note that the interest yield curve (NSS method) described above that is applied for estimating the risk-free interest rate is consistent with this exchange rate forecasting method. The interest yield curves of both currencies determine the arbitrage-free, period-specific (synthetic) forward exchange rate.

This all leads to an important insight that is essential to providing a consistent valuation model: when the CAPM (and the NSS method) is applied, the CAPM-consistent exchange rate forecasting method has already been determined, implying the application of the *risk-adjusted forward rate method*. Practitioners that use other approaches to estimate future exchange rates that deviate substantially from the corresponding (risk-

[40] Figure 1 is an adapted version of the figure presented in *Breuer/Ruiz de Vargas/Schüler* DB 2021, Wechselkurse und Unternehmensbewertung: Anmerkungen zur Ergänzung der Fragen & Antworten zum IDW S 1, pp. 1961, 1965.

adjusted) forward rates are not applying the CAPM and the NSS method in a consistent manner.

V. Conclusion

An implication of the CAPM is that the diversification principle applies. In the case of well-integrated capital markets in developed countries, rational investors diversify across borders to benefit from the diversification advantages that are obtainable in an expanded universe of readily available capital assets. In this case, the traditional local market portfolio becomes obsolete. Only the *global market portfolio* reflects the valuation-relevant expected returns and systematic risk. As a consequence, the global (and not the local or domestic) CAPM is applicable.

This note provides guidance to practitioners on how to use the global CAPM from the standpoint of investors that use the euro as their reference currency. The risk-free rate estimate is the same as in the local CAPM since the price of immediate consumption in a single currency area does not change. However, the global and not the local market portfolio becomes relevant in relation to the pertinent investment opportunities. Then the price of risk requires an estimate of the global equity risk premium for an economic regime that is shaped by liberalized capital markets and free-floating exchange rates.

According to a recent empirical study based on the historical approach, a global equity risk premium of approx. 6.0% can be applied from a *euro* perspective. This estimate is consistent with an economic regime with flexible exchange rates and liberalized capital markets. In relation to the (global) beta factor, this note shows that a currency conversion effect and a diversification effect must be considered. A further implication of the (global) CAPM is that it also provides a method for forecasting future exchange rates, i.e. the (risk-adjusted) forward-rate method.

In Goldman Sachs Asset Management's investment handbook, the global CAPM provides the benchmark for portfolio optimization ("[...] *the global CAPM equilibrium provides this center of gravity*."[41]). Since the sixth edition (2015), repeated in the seventh edition (2020), of the well-known valuation handbook *Koller, Goedhart and Wessels*, the application of the global CAPM is explicitly recommended ("*Global CAPM* [...] *We recommend this approach because markets are global*. [...] *Nevertheless, we don't recommend the local CAPM approach for integrated markets, for several reasons*."[42]). *Stulz* recommended its application as early as 1995 ("*Instead of using a local CAPM* [...], *I recommend use of a global CAPM* [...]."[43]) and repeated this recommendation in 1999 ("*In measuring the risk of individual firms and projects, use the global (not the local) CAPM*."[44]). In valuation cases where the precept of the best possible estimate is to be observed the global CAPM is preferable to the traditional local CAPM for well-integrated capital markets[45]. The purpose of this note is to facilitate the adoption of the global CAPM in order to provide consistent and theoretically sound valuations in practice ("*one cannot do better than using the global CAPM*"[46]).

Appendix

The expected return on a risk-free bond in a foreign currency (FC) from the perspective of a local investor in the reference currency (€) is $E\left[R_{FC(€)}\right]$, which is composed of the risk-free interest $R_{f,FC}$ in the foreign currency (FC) and the expected exchange rate change $E\left[X_{€/FC}\right]$ (exchange rate return). The investment ($A_{€,t}$) in the investor's home currency (€) must first be converted into the foreign currency at the spot exchange rate $1/S_{€/FC,t}$ at Period t. Due to the investment in risk-free FC-denominated securities, it generates the return $R_{f,FC}$, which is converted from the foreign currency (FC) to the home currency (€) at the future spot exchange rate $S_{€/FC,t+1}$ in Period $t+1$. The following applies in arbitrage-efficient and speculation-efficient integrated capital markets:

$$A_{€,t} \cdot \left(1 + E\left[R_{f,FC€}\right]\right) = A_{€,t} \frac{E\left[S_{€/FC,t+1}\right]}{S_{€/FC,t}} \cdot \left(1 + R_{f,FC}\right). \quad (A.1)$$

[41] *Litterman* in Modern Investment Management: An Equilibrium Approach, 2003, p. 76.

[42] *Koller/Goedhart/Wessels* Valuation: Measuring and Managing the Value of Companies, 7. ed. 2020, pp. 512 f., 516.

[43] *Stulz* Journal of Applied Corporate Finance 1995, Globalization of capital markets and the cost of capital: The case of Nestlé, pp. 30, 38.

[44] *Stulz* Journal of Applied Corporate Finance 1999, Globalization, Corporate Finance, and the Cost of Capital, pp. 8, 24.

[45] Recall that the international CAPM provides a theoretically superior method (see for example, *Ejara/Krapl/O'Brien/Ruiz de Vargas* Journal of Investment Management 2020, Local, Global, and International CAPM: For Which Countries Does Model Choice Matter?, pp. 73 ff.). However, the application in practice is substantially more difficult; therefore, it tends to be used less frequently.

[46] *Stulz* European Financial Management 1995, The cost of capital in internationally integrated markets: The case of Nestlé, pp. 11, 18.

In consideration of $1 + E[X_{€/FC}] = E[S_{€/FC,t+1}]/S_{€/FC,t}$, the following relation results:

$$\begin{aligned}\left(1+\mathrm{E}\left[\mathrm{R}_{\mathrm{f,FC€}}\right]\right)&=\left(1+\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]\right)\cdot\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)\\ \mathrm{E}\left[\mathrm{R}_{\mathrm{f,FC€}}\right]&=\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]+\mathrm{R}_{\mathrm{f,FC}}+\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]\cdot\mathrm{R}_{\mathrm{f,FC}}.\end{aligned} \tag{A.2}$$

The expected return on the risk-free investment in a foreign currency can also be represented by the global CAPM as follows:

$$\mathrm{E}\left[\mathrm{R}_{\mathrm{FC€}}\right]=\mathrm{R}_{\mathrm{f€}}+\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}. \tag{A.3}$$

Inserting (A.2) into (A.3) yields:

$$\begin{aligned}&\mathrm{R}_{\mathrm{f€}}+\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}=\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]+\mathrm{R}_{\mathrm{f,FC}}+\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]\cdot\mathrm{R}_{\mathrm{f,FC}}\\ &\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)=\mathrm{R}_{\mathrm{f€}}-\mathrm{R}_{\mathrm{f,FC}}+\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}\\ &\mathrm{E}\left[\mathrm{X}_{€/\mathrm{FC}}\right]=\frac{\mathrm{R}_{\mathrm{f€}}-\mathrm{R}_{\mathrm{f,FC}}}{\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)}+\frac{1}{\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)}\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}.\end{aligned} \tag{A.4}$$

Assuming the validity of the covered interest rate parity theory (CIP), $F_{€/\mathrm{FC,t,t+1}} = S_{€/\mathrm{FC,t}}(1 + R_{f€})/(1 + R_{FC})$ holds.

The CIP therefore implies $(R_{f€} - R_{f,FC})/(1 + R_{f,FC}) = (F_{€/\mathrm{FC,t,t+1}} - S_{€/\mathrm{FC,t}})/S_{€/\mathrm{FC,t}}$. In consideration of $E[X_{€/\mathrm{FC}}] = (E[S_{€/\mathrm{FC,t+1}}] - S_{€/\mathrm{FC,t}})/S_{€/\mathrm{FC,t}}$, per definition, the following method for forecasting exchange rates can be derived from the global CAPM after the appropriate transformations from (A.4):

$$\begin{aligned}&\frac{\mathrm{E}\left[\mathrm{S}_{€/\mathrm{FC,t+1}}\right]-\mathrm{S}_{€/\mathrm{FC,t}}}{\mathrm{S}_{€/\mathrm{FC,t}}}=\frac{\mathrm{F}_{€/\mathrm{FC,t,t+1}}-\mathrm{S}_{€/\mathrm{FC,t}}}{\mathrm{S}_{€/\mathrm{FC,t}}}+\frac{1}{\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)}\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}\\ &\mathrm{E}\left[\mathrm{S}_{€/\mathrm{FC,t+1}}\right]-\mathrm{S}_{€/\mathrm{FC,t}}=\mathrm{F}_{€/\mathrm{FC,t,t+1}}-\mathrm{S}_{€/\mathrm{FC,t}}+\frac{\mathrm{S}_{€/\mathrm{FC,t}}}{\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)}\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}\\ &\mathrm{E}\left[\mathrm{S}_{€/\mathrm{FC,t+1}}\right]=\mathrm{F}_{€/\mathrm{FC,t,t+1}}+\overbrace{\mathrm{S}_{€/\mathrm{FC,t}}\frac{\left(1+\mathrm{R}_{\mathrm{f€}}\right)}{\left(1+\mathrm{R}_{\mathrm{f,FC}}\right)}}^{\mathrm{F}_{€/\mathrm{FC,t,t+1}}}\frac{\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}}{\left(1+\mathrm{R}_{\mathrm{f€}}\right)}\\ &\mathrm{E}\left[\mathrm{S}_{€/\mathrm{FC,t+1}}\right]=\mathrm{F}_{€/\mathrm{FC,t,t+1}}\left(1+\frac{\mathrm{MRP}_{\mathrm{G}}\cdot\beta_{\mathrm{X,G}}}{\left(1+\mathrm{R}_{\mathrm{f€}}\right)}\right).\end{aligned} \tag{A.5}$$

Since the CAPM is a single-period model, and the interest yield curve must be observed, it is advisable to apply this equation on a roll-back basis for all forecasting periods in the detailed planning period. Note that this exchange forecasting method applies along the full interest yield curve, which encompasses a forecasting period of up to 30 years in many developed countries.

The valuation of National Recovery and Resilience Plan - NRRP (or Piano Nazionale di Ripresa e Resilienza - PNRR) funded investments: estimating the Cost of Capital*

Marco Vulpiani** - Federico Grassi*** - Matteo Mazzei****

This paper describes a possible approach for estimating the cost of capital for projects partially financed by the National Recovery and Resilience Plan (NRRP) funds. Starting from the general framework of cost of capital estimation, the proposed approach defines an appropriate cost of capital for capital budgeting of investments financed with public contribution, focusing on methodologies related to estimating the minimum required return on public capital financed projects.
More in detail, the study proposes an estimation of cost of capital specifying the capital allocated through the different resources made available by the different sources. With reference to the funds made available from the NRRP, or more in general from the Next Generation EU (NGEU) programs, both *loans* and *grants*, distinguished from traditional sources, a calculation method to identify the required returns is presented.
The analysis shows a benefit in terms of decrease of the project's cost of capital due to financing from NRRP funds, which allows projects to be undertaken with lower returns than similar projects financed from traditional sources, favoring lower cost of resources, with reflections on the social value of the initiatives in terms of projects promotion.

1. Introduction to NRRP

In the early 2020s, the spread of the SARS-CoV2 virus, or Covid-19, hit Europe and the rest of the world, necessitating unprecedented containment measures with the aim of stemming its spread. The epidemic waves, with the health crisis that followed, destabilized the economic and social fabric as a whole, causing severe repercussions on a system that had already faced two global financial crises in the previous two decades.

The response to the ongoing economic crisis was initially national in nature, and economic measures aimed at recovery involved heterogeneous forms of support, including relief, tax relief, guarantees and moratoria. However, the severity of the financial imbalance required centralized and supranational intervention in order to succeed in healing the negative consequences found on the productive fabric and employment.

Against this backdrop, in May 2020 the European Commission presented the "Plan for Europe's Recovery"[1], including both an enhancement of some of the programs contained in the so-called Multiannual Financial Framework (MFF) 2021-27 and new instruments, the most important of which is the Next Generation EU (NGEU) program.

Overall, the instruments set up to support member states for investment and reform involved resources totaling more than 2.3 trillion euros, distributed among the MFF 2021-2027, State sUpported shoRt-timE work (SURE) interventions, the European Investment Bank (EIB), the European Stability Mechanism (ESM), and the new NGEU facility[2].

The NGEU consists of several instruments, the most important of which is the Recovery and Resilience Facility or RRF, while others include resources drawn from other funds and programs, such as React-EU, InvestEU, the Horizon Europe program or the Just Transition Fund. The total resources provided by the

* The views and opinions expressed in this study are solely those of the authors. They should not be interpreted in any way as reflecting the perspectives of the institutions which the authors represent.

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[1] Ufficio Parlamentare di Bilancio (UPB), *Rapporto sulla programmazione di bilancio 2020 and Il programma di rilancio Next Generation EU*, 2020.

[2] Ministero dell'Economia e delle Finanze website, *Next Generation EU e Recovery and Resilience Facility*, 14 aprile 2021, mef.gov.it.

NGEU at the European level amount to about €750 billion[3].

Regulation (EU) 2021/241 established the Recovery and Resilience Facility (RRF) containing forecasts with reference to the total amount and allocations of resources to be allocated among member states, as well as a description of the requirements for their access. The total programmed resources, approximately €672.5 billion, are expected to be raised through a combination of loans, grants and other funds. More specifically, the RRF[4] has an allocation divided between 312.5 billion payable through grants (*grants*) and 360 billion in loans (*loans)*[3].

In order to access the resources provided by the NGEU, each state had to submit to the European Commission a coherent package of reforms and investments for the period 2021-2026, making financial support conditional on compliance with a detailed plan in terms of projects, measures and planned reforms. These had to revolve around six areas of intervention, identified in the following pillars[5]:

I. Green transition;
II. Digital transformation;
III. Smart, sustainable and inclusive growth;
IV. Social and territorial cohesion;
V. Health and economic, social and institutional resilience;
VI. Policies for the next generation.

The disbursement of the resources will last between 2021 and the end of 2026[6], while the horizon for repayment of the amounts received will start from 2028 with a deadline set for 2058[7]. The amount pertaining to the loans, will be repaid by the beneficiary states, while the grants from the EU budget. Resources will also be raised through the Commission's issuance of *bonds*, with different time horizons and in the observance that 30 percent of them will be issued in the form of *green bonds*[8].

The Italian government submitted its proposal to the Commission on April 30, 2021 to gain access to RRF resources on the basis of its National Recovery and Resilience Plan, better known as NRRP. The Italian NRRP is developed around six missions, in compliance with the provisions contained in Regulation 2021/241 and was approved, by Council Implementing Decision, on July 13, 2021[9]. The Plan has three main objectives, with three different time horizons. The first involves repairing the economic and social damage caused by the pandemic crisis, the second seeks to address territorial gaps, gender disparities, weak growth, and low productivity, and the last is aimed at a complete ecological transition[10].

Italy is the largest beneficiary in Europe of RRF resources, having applied for the maximum amount within the stipulated parameters of €191.5 billion, divided between 68.9 billion in grants and 122.6 billion in loans[11].

Contained within the request document sent to the European Commission is the draft reform and allocation of the requested resources, distributed among the six missions and multiple sub-missions, each of which is defined through subject matter, objectives and programs in line with the requests set forth within Regulation 2021/241.

In order to achieve the purposes pictured in the NRRP, the latter does not only consider the use of European resources, but further envisages drawing on resources from the Fondo Investimento Complementare in the total amount of approximately €30.6 billion. Furthermore, considering the resources arranged by Europe, in addition to those already mentioned above, €13.5 billion from the React-EU fund[12], also by way of grants, are relevant. The total available to the NRRP therefore reaches the amount of €235.6

[3] Prices as of 2018. Source: Ministero dell'Economia e delle Finanze, *Il piano Nazionale di Ripresa e Resilienza (PNRR)*, May 25, 2021. For comparison with 2020 prices, see European Commission, *The EU as a borrower - investor relations, Next Generation EU*, commission.europa.eu.

[4] Camera dei deputati website, Documentazione parlamentare, *Il piano nazionale di ripresa e resilienza*, 2022, temi.camera.it.

[5] XVIII Legislatura, dossier, Senato della Repubblica e Camera dei deputati, *Proposed National Recovery and Resilience Plan, 2021 NRRP: financial data and framework of resources and uses*, November 2021.

[6] *The RRF Regulation and the amendments to the Structural Funds Regulation related to the introduction of the ReactEU program made it possible to also allow funding for interventions adopted as of February 2020*, Ufficio Parlamentare di Bilancio (UPB), *L'impatto finanziario del Piano nazionale di ripresa e resilienza,* Flash No. 1/21 May 2021.

[7] European commission website, *Repayment of the borrowing*; XVIII Legislatura, dossier, Senato della Repubblica e Camera dei deputati, *PNRR: dati finanziari e quadro delle risorse e degli impieghi*, November 2021.

[8] European commission website, *NextGenerationEU Green Bonds*, commission.europa.eu.

[9] European Commission, COM/2021/344 final, *COUNCIL IMPLEMENTING DECISION on the approval of the assessment of the recovery and resilience plan for Italy*, 2021.

[10] Italiadomani website, *PNRR, gli obiettivi e la struttura*, italiadomani.gov.it.

[11] Italiadomani website, *Piano Nazionale di Ripresa e Resilienza,* June 25, 2021, italiadomani.gov.it.

[12] Acronym for Recovery Assistance for Cohesion and the Territories of Europe (React-EU). It is an EU program created with an allocation of 50.6 billion euros in current prices with the aim of "promoting the overcoming of the negative effects of the health crisis on the economy, employment and social systems a and at the same time fostering the green and digital and resilient transition of economy and society.". Compared to the 13.5 Billion initially requested and approved, it was decided to strengthen the current programming by further endowing the requested amount of resources with additional resources, up to an amount of 14.4 Billion. Source: Presidenza del Consiglio dei Ministri, Dipartimento per le politiche di coesione, *Programmazione delle risorse React-EU: Linee di intervento per le risorse relative all'annualità 2022 e quadro complessivo*, March 2022.

billion for the period between part of 2020 and 2026[13].

Below is a table summarizing the distribution of resources during the period under consideration based on the total amount by type of resource[14].

Figure 1. Resources provided through NRRP - Breakdown by source

Eur/Billion	RRF Loans	RRF Grants	React-EU Grants	FIC(*)	Total NRRP resources
2020	1.6	0.0	0.0	0.0	1.6
2021	6.8	6.9	10.6	3.0	27.3
2022	12.7	14.8	2.8	6.0	36.3
2023	16.2	21.2	0.0	6.8	44.2
2024	29.4	13.4	0.0	6.2	48.9
2025	30.1	8.3	0.0	5.5	43.8
2026	25.8	4.3	0.0	3.2	33.2
TOTAL	122.6	68.9	13.5	30.7	235.6
*Fondo Investimento Complementare					

2. The valuation of projects financed with NRRP funds

The development opportunities and macroeconomic implications arising from the use of NRRP funds constitute matters of national and supranational interest. In this context, it seems clear that attention to the targeting of investments and the intrinsic characteristics of funded projects cannot be separated from the efficient allocation of available resources in terms of cost-effectiveness and financial sustainability.

Economic viability and financial sustainability are respectively declined in the ability of the project to generate value over the defined time frame with a level of profitability capable of remunerating the invested capital, while sustainability refers to the ability of the projected flows to repay the financing contracted. In fact, economic and financial sustainability takes the form of verifying that the project's return is in line with the expectations of the parties involved and sufficient to remunerate the cost of the financing sources. Therefore, in the analysis of the value created by investments also financed with the NRRP, the discount rate estimation assumes importance, as it must be capable of reflecting the specific financial structure adopted for financing the project as a whole.

In particular, the difficulty in verifying the financial sustainability or the value created by a project financed through NRRP funds lies in the complexity of estimating an appropriate cost of capital for the investment, due not only to the presence of public and private investors with different expected *targets* of return (Paul A. Grout, 2003)[15], but also to the particular macroeconomic *framework* in which the NRRP is framed.

In the NRRP context, as in any other investment, the internal rate of return (IRR) must be greater than the weighted average cost of capital (WACC) of the project (Bonnafous, A. & d'Arcier B. F., 2013), given the specific characteristics of the actors involved[16]. Whether WACC may benefit from the presence of a component of public funding is a highly controversial issue that has generated heated debate in the literature. The general perspective agrees that the collaborative scheme between private actors and the public sector brings greater financial efficiency to the project (Hellowell M. & Vecchi V., 2018)[17], allowing the public operator to provide financing at a lower cost than would be the case with "traditional" funding. This process optimization is brought in by the private operator and is remunerated through a decrease in the project WACC, which is affected by the lower performance required by the public sector[18]. Consistent with the previous *view*, Paul A. Grout[19] shows that there are strong arguments for using a higher discount rate for private projects than for public sector projects.

The possibility of making adjustments to the WACC calculation in order to reflect the impacts of public intervention in project financing schemes had already emerged in literature in the context of assessing the effect of government subsidies on the cost of capital (Fernandez, Tham, Vélez-Pareja, 2005)[20]. Again, the proposed formulation results in a lower weighted average cost of capital, positively influenced by the presence of public funding sources.

This study aims to analyze the various complexities

[13] Ufficio Parlamentare di Bilancio (UPB), *L'impatto finanziario del Piano nazionale di ripresa e resilienza*, Flash n. 1/21, May 2021.

[14] The table presents the amount of the annual distribution of NRRP resources sent to the European Commission. For the React-EU, the distribution of amounts has been updated on the basis of the two EU Implementing Decisions No. 182/2021 and 2055/2021, respectively, with the amount planned for 2021 and 2022 (2018 Pre-Resource Prices).

[15] Grout, P. A. (2003), *Public and private sector discount rates in public-private partnerships*, The Economic Journal, 113(486), C62-C68.

[16] Bonnafous, A., & d'Arcier, B. F. (2013, July), *The conditions of efficiency of a PPP for public finances*, In 13th WCTR-13th World Conference on Transportation Research.

[17] Hellowell, M., & Vecchi, V. (2018), *Assessing the cost of capital for PPP contracts. Public-Private Partnerships in Health: Improving Infrastructure and Technology*, 85-109.

[18] Bonnafous, A., & d'Arcier, B. F. (2013, July), *The conditions of efficiency of a PPP for public finances*, In 13th WCTR-13th World Conference on Transportation Research.

[19] Grout, P. A. (2003), *Public and private sector discount rates in public-private partnerships*, The Economic Journal, 113(486), C62-C68.

[20] Velez-Pareja, I., Tham, J., & Fernández, V. (2005), *Adjustment of the WACC with Subsidized Debt in the Presence of Corporate Taxes: the N-Period Case. Estudios de Administración*, 12(2), 45-66.

above and to propose the formulation of a discount rate that is representative of the appropriate remuneration in the presence of NRRP contributions among the funding sources.

3. The estimation of the cost of capital

3.1. The general formulation of the cost of capital

Given the purposes of the analysis and the economic and financial sustainability criteria identified, this study aims to present some ways to identify a formulation of the weighted average cost of capital that can reflect the return expectations of the various stakeholders and the cost of the project's financing sources in the case of investments framed under the NRRP.

The weighted average cost of capital (WACC) corresponds to the opportunity cost of capital used to finance an investment and is used to discount the cash flows generated by the project. The weighted average cost of capital, in addition to reflecting the riskiness of the project, must take into account the different sources of financing and the different rates of remuneration expected by the various financing entities; it must therefore reflect the structure used to finance the project, distinguishing the weight of the sources used.

With regard to estimating the capital cost of an investment financed with NRRP funds, a general formulation expressing an overall structure financed partly by public capital and partly by private capital found in the market, consisting of both equity and debt, is proposed below.

$$WACC_{project} = K_P * W_P + K_S * W_S$$

Where:
K_p: cost of private capital;
W_p: relative weight of traditional sources in the total disbursed under the project;
K_s: cost of public capital;
W_s: relative weight of public sources.

The $WACC_{proget}$ represents the overall discount rate of the project, i.e., the minimum return on investment that can guarantee affordability. The overall WACC of the project takes into account both the cost of traditional sources (K_p) and its contribution to total sources (W_p) and the amount from public sources (W_s) and the relative cost of public capital (K_s) (in this case provided through the NRRP scheme).

In the following sections, the study will proceed to analyze the components of the project discount rate, providing an empirical application of the proposed formulation.

3.2. Private capital (K_p)

By applying a progressive segregation of components to calculate the $WACC_{proget}$, it is possible to identify the cost of traditionally commercially available sources (K_p) with the cost of private capital. In fact, from a practical point of view, the return on investment must be able to remunerate the resources employed in the project. Accordingly, the K_p can be determined through the classical formulation of WACC:

$$K_P = K_e * W_e + K_d(1-t) * W_d$$

Where:
K_e: cost of own means;
W_e: weight of venture capital;
$K_d\ (1-t)$: cost of financial debts (net of tax shield);
W_d: weight of financial debt.

The cost of equity (K_e) is defined as the opportunity cost of risk capital. For the purpose of its determination, various models have been developed by the doctrine, of which the most accredited is the *Capital Asset Pricing Model* (hereinafter "CAPM"), defined as:

$$K_e = r_f + \beta * MRP$$

Where:
r_f: return on risk-free assets;
β: coefficient relating to "non-diversifiable" risk (*systematic risk*);
MRP: market risk premium.

The cost of debt capital ($K_d\ (1-t)$) is equal to the average rate on onerous debt net of the project's average effective tax rate, applied to account for tax deductibility of borrowing costs. A method to estimating the cost of debt is to add to the risk-free rate (r_f) a *spread* representative of the project's creditworthiness.

In order to determine the financial structure, it is necessary to refer to the composition of capital raised through traditional sources within the project, identifying the percentage of funds obtained through equity and the proportion of debt required to finance the investment.

3.3. Public capital (K_s)

Estimating the cost of the public component financed through funding sources such as the NRRP follows different calculation logic, since it is based

on a different process of assessing the risk component and, therefore, remuneration.

Before proceeding to a detailed discussion of the calculation methodology applicable in this context, it seems necessary to recall some of the specific features of the assistance measures, such as the Recovery and Resilience Facility (RRF) and the NRRP, in order to properly define the context in which they are embedded. The two instruments, in fact, fall into the category of extraordinary assistance measure, introduced in a global crisis context, with the purpose of supporting and sustaining, respectively, the European and national economies.

The European Union, for the purpose of financing part of the RRF instruments, has undertaken for the period 2021-2027 a program of public auctions for the purchase of financial instruments aimed primarily at institutional investors. The two instruments identified for this purpose are[21]: *i)* European bonds or EU-Bonds with *maturities* between 3 and 30 years and *ii)* EU-Bills with a maximum *maturity* of one year[22].

By raising this financing, the European Union will be able to disburse the planned resources through two distinct forms of support to member states: *loans* and *grants*. The analysis of bond issues in the European context, in this context, is instrumental in defining an appropriate rate of return.

The outline of the NRRP stipulates that:

I. The amount of the *loans* received will be fully repaid by the borrowing states. To define the expected return on the *loans*, it is possible to analyze the EU-bonds that have already been placed, and more specifically the *time to* maturity and the yield *to maturity*, that is, the yield on a particular bond assuming it is not liquidated until maturity.

II. *Grants*, unlike *loans*, are disbursed as grants and therefore, although a direct reimbursement mechanism has not been defined to date, it can be assumed that they will be (partially) reimbursed by the beneficiary states through their annual contributions to the EU Budget.

Estimating the cost of public capital in the context of a project financed through funds allocated by the NRRP can thus be done by referring to the two different remuneration components required by the EU related to the instruments just described. Specifically, for the purposes of this discussion, the following considerations were made:

Loans – the *yield was* estimated to be equal to the average *yield to maturity* considering a *maturity* equal to a typical financed project duration (between 15 and 20 years). The yield thus identified was 3.3%[23], as of June 30th, 2023.

Figure 2. Required returns on loans as of June 30th, 2023

Time To Maturity (TTM)	Yield To Maturity (YTM)
3	3.13%
4	3.06%
5	3.03%
6	3.02%
7	2.98%
8	2.99%
9	3.01%
10	3.03%
11	3.13%
13	3.21%
14	3.23%
15	3.33%
18	3.34%
19	3.37%
20	3.32%
24	3.26%
25	3.32%
27	3.22%
28	3.24%
29	3.37%
30	3.38%

Grants – grants disbursed at European level, due to the absence of obligation for reimbursement by the recipient states, which is characteristic of non-repayable grants, have no explicit remuneration. However, since the funds are provided by the European Union at centralized level, the grants are indirectly financed by the member states through their annual contributions to the Union.

Therefore, for the purpose of estimating the expected return related to grants, since it is not known how much will be returned by the individual member states, it has been assumed that the grants will be reimbursed indirectly, i.e. through the contributions paid annually to the European Union. According to this approach, Italy's reimbursement was assumed equal to the ratio between the weight of the annual contributions paid to the EU compared to the other member states and the weight of the grants received by Italy compared to the other member states.

Specifically, the share of the annual contribution paid by the country Italy was first determined indirectly. With reference to 2022, about €19.9 billion of the total 157.7 (contributed by the 27 Member States) were paid, constituting about 12.6 percent of the contributions[24].

Next, the incidence of the aforementioned contribution on the grants allocated to the country Italy pro-

[21] Source: *EU-Bonds*, *EU-Bills*, Funding instruments, commission.europa.eu.

[22] For the purpose of this discussion, only EU-Bonds will be considered, which are characterized by a time horizon more in line with the typical duration of projects that have the characteristics of affordability and financial sustainability.

[23] Specifically, the one-month average as of June 30, 2023 was used. Source: author's elaboration on Refinitiv data.

[24] Source: 3. Official Journal of the European Union, *DEFINITIVE ADOPTION (EU, Euratom) 2022/182 of the European Union's general budget for the financial year 2022*, February 2022.

vided within the NRRP was calculated compared to the total provided by the RRF program and React-EU (Figure 1). Of the €363.1 billion[25] made available by the EU in the form of grants for the two instruments, Italy requested €68.9 billion from the RRF and €14.4 billion from React-EU[26], representing about 23% of the total available at the European level, suggesting a hypothetically indirectly reimbursed share by Italy of 55.0% (12.6% / 23%).

In the specific context of the NRRP, the grant remuneration component was estimated as the cost to the European Union of the resources allocated to Italy, considering the following flows as cash outflows/income:

- Disbursement equal to the amount of grants allocated to Italy based on the Italy-EU agreements for the period 2021-2026[27] (Figure 1);
- Repayment over the 30-year period 2028-2058, referring, as a benchmark, to the foreseen repayment schedule of *loans* included in the NextGenerationEU perimeter[28], of a 55.0% share of the funds obtained. As described above, the repaid share was estimated as the ratio between the incidence of the contributions paid by Italy to the annual European Budget (12.6%) and the share of *grants* given to Italy compared to the total grant resources provided in total by the RRF and React-EU (23%).

Based on these considerations, a yield of approximately negative 2.8 percent can be identified, as summarized in the table below.

Figure 3. Calculation of return on grant resources (grants)

Total grant resources	83.3									
Indirectly percentage reimbursed	55.0%									
Year	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028 […]**	**2057**	**2058**
Eur/Billion										
Resource allocation: RRF	(11.5)	(23.0)	(10.3)	(8.6)	(6.9)	(8.5)	-	-	-	-
Resource allocation: React-EU	(11.3)	(3.1)	-	-	-	-	-	-	-	-
Indirect repayment of resources	-	-	-	-	-	-	-	1.5	1.5	1.5
Cash Flow	**(22.8)**	**(26.1)**	**(10.3)**	**(8.6)**	**(6.9)**	**(8.5)**	**-**	**1.5**	**1.5**	**1.5**

Return	-2.8%

Considering the findings of the analyses conducted on the returns on *loans* and *grants* – described above – based on their respective characteristics, the formula for calculating the cost of public capital, including the two components described above, can be introduced.

$$K_S = K_{Dloans} * W_{loans} + K_{Dgrants} * W_{grants}$$

Where:
K_s: cost of public capital;
K_{Dloans}: expected return of financing (*loans*);
W_{loans}: weight of financing (*loans*);
$K_{Dgrants}$: expected return of grants;
W_{grants}: weight of grants.
i.e.:

$$K_S = 3.3\% * 59.6\% + (2.8\%) * 40.4\% = 0.9\%$$

The weight of loans and grants can be obtained by considering the composition of the resources provided by the EU to Italy, i.e., 40.4 percent for *loans* and 59.6 percent for grants, calculated in consideration of the €122.6 billion in loans and €83.3 billion in grants.

3.4. The capital cost of projects financed through NRRP funds

To conclude the considerations made and for the purpose of illustrating the impact of the disbursement of sources financed through NRRP funds on the cost of project capital ($WACC_{Project}$), an illustrative example is presented in which the rates of return related to the components of traditional sources (K_p) and public (K_s) and their respective weight in the total sources used within the project are estimated assuming a structure financed 60 percent through traditional sources and the remaining 40 percent through NRRP funds allocated to the project. A cost of traditional sources of 10% was assumed.

$$WACC_{project} = K_P * W_P + K_S * W_S = \\ = 10.0\% * 60\% + 0.9\% * 40\% = 6.3\%$$

Where:
K_p: cost of capital traditional sources;
W_p: relative weight of traditional sources in the total disbursed under the project;
K_s: cost of public capital;
W_s: relative weight of public sources disbursed through the NRRP to the total required by the project.

Thus, a reduction in project WACC of about 3.7 percentage points emerges, attributable to the weight of public capital resources, which having an advantageous rate of return are able to lower the cost of capital as a whole. The direct reflection of the reduction in the cost of project capital is to give an option to investors to be able to undertake projects that have a lower return than the opportunity cost of similar projects financed through traditional sources.

[25] Including 312.5 billion from the RRF facility and 5.6 from React-EU.

[26] Compared to the initially requested and approved 13.5 Billion, it was decided to strengthen the current programming by further endowing the requested amount of resources with additional resources, up to an amount of 14.4 Billion. Source: Presidenza del Consiglio dei Ministri, Dipartimento per le politiche di coesione, *Programmazione delle risorse React-EU: Linee di intervento per le risorse relative all'annualità 2022 e quadro complessivo*, March 2022.

[27] Source: Recovery and Resilience Facility, *Operational arrangements between the European Commission and Italy*, commission.europa.eu.

[28] European Commission website, *Repayment of the borrowing*, commission.europa.eu.

4. Conclusions

The purpose of the discussion was to present a possible approach for estimating the cost of capital of a project financed through NRRP funds in order to analyze its effects and implications on financial viability.

After a brief presentation of the context in which the European Union's assistance interventions are set with the NGEU and within it the RRF, Italy's response to the economic crisis, represented by the National Plan for Recovery and Resilience (NRRP) and its submission to the European Commission in order to be eligible for part of the allocated funds (*loans* and *grants*), was described. The Commission, in compliance with procedural requirements, allocated about €122.6 billion in loans (*loans*) and €83.3 billion in grants (*grants*).

The NRRP, through the areas of intervention, will allocate the resources received to a set of projects with subject matter, objectives and programs in line with the requirements set forth within the European Regulations.

In order to estimate the impact of these resources on the capital costs of the projects they finance, the methodologies applied in professional practice for calculating the cost of capital (WACC) were first analyzed, and then these were declined to reflect the impacts of public intervention through the distinction between traditional sources and capital provided by NRRP resources.

Verifying the cost-effectiveness of a project financed through NRRP lies in the complexity of estimating an appropriate rate of return on the investment, for which the target return must be higher than the WACC.

The discussion therefore focused on methodologies related to estimating the minimum required return on public capital financed through NRRP resources. Two sub-components were identified and described, based on the financing scheme in which these are provided: *loans* and *grants*. For the former, the estimation of the return involved the analysis of the return on the loans disbursed to the European Union through EU-Bonds, loans used in turn for the disbursement of resources to the beneficiary states of the assistance instruments, while for the latter, an analysis was conducted that led to the identification of the return considering the resources distributed to Italy on a grant basis and the resources indirectly returned through the annual contribution to the EU Budget.

After calculating the return on public capital, an example was presented for estimating the capital cost of a hypothetical project assuming a 40 percent financing structure through NRRP funds. The result that emerged identified a benefit in terms of a decrease in the cost of capital of the project, highlighting how financing through NRRP funds makes it possible to undertake projects characterized by lower returns than the opportunity cost of similar projects financed through traditional sources, benefiting a lower cost of resources, with reflections on the social value of the initiatives in terms of projects promotion.

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