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Return on investment for the Swedish energy network sector

A report for Energimarknadsinspektionen

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We conduct research at the Centre for Research on Geography, Resources, Environment, Energy & Networks at Bocconi University (GREEN) and at the Florence School of Regulation, where Mr Pototschnig is Deputy Director, World of Practice.

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INTRODUCTION

We have been commissioned by Energimarknadsinspektionen (Ei), the Swedish energy regulatory authority, to assess some aspects related to the treatment of capital expenditure in the economic regulation of energy network activities in Sweden.

Ei sets allowed revenues for Swedish gas and electricity network operators by implementing a revenue cap methodology that runs over four-year regulatory periods and relies on:

- a weighted-average cost of capital (WACC) to set the rate of return, where the capital asset pricing model (CAPM) is used to determine the return on equity;
- for the electricity sector, a replacement-cost methodology to set the regulated asset value (RAV) at the beginning of each regulatory period and RAV indexation, using a sector-specific inflation index, within the regulatory period;
- for the gas sector, the RAV of each asset determined at historical costs, and then revalued on a yearly basis using a sector-specific inflation index.

Ei is considering:

- reviewing the current WACC/CAPM methodology to set the allowed rate of return; and
- moving from the current RAV-setting methodologies to an alternative one, based on historical costs.

In this context, we have been asked to assess the opportunity to employ alternative methodologies to set the allowed rate of return for the Swedish energy network sector, considering the current and expected market and regulatory context.

The views and opinions expressed in this document are those of the authors and do not necessarily reflect the views or positions of Ei.

The rest of the document is organised as follows. In Section 1, we outline a conceptual framework for defining the allowed revenues to cover capital expenditures. In Section 2 we describe the current methodology used by Ei to set the allowances to cover capital expenditures in the Swedish energy network sector and the one being considered by Ei. In Section 3 we identify and review the main theoretical and practical approaches to set the cost of capital and assess the opportunity to use them in the context of the economic regulation of energy networks. In Section 4 we present our main findings and considerations on possible ways forwards.

1. ALLOWED REVENUES AND CAPITAL EXPENDITURE

Regulators typically determine the level of the allowed revenue for a regulated business – e.g. a network undertaking - in order to cover both (efficient/prudently incurred) operation and maintenance costs (OPEX) and capital costs (CAPEX)[1]. The latter is intended to provide the remuneration of the 'Regulatory Asset Base' (RAB), the set of assets, possibly approved by the regulator, which is deemed necessary for the provision of the network services. The value of the RAB is usually referred to as the 'Regulatory Asset Value' (RAV)

The allowed revenue intended to cover CAPEX is itself composed of two components:

- a component to cover the depreciation[2] of the RAB, i.e. to recover the value of the capital invested in the assets used to deliver the network services in a specific period ('return of capital')[3];
- a component to cover the cost of capital, i.e. to compensate for the capital invested in the business ('return on capital').

Every year, the RAV is typically adjusted by:

- subtracting the depreciation of the assets in the RAB over the previous year; and
- adding the value of the new assets (possibly approved by the regulator and) included in the RAB.

Depending on the methodology used by the regulator, the RAV could also be revalued, typically at the beginning of each year.

In a specific year, the allowed return on capital is defined as the product of:

- the RAV at the beginning of the year; and
- the allowed rate of return on capital.

The latter is generally a weighted average of the costs of the two main sources of capital - equity capital and debt capital - as recognised in regulation. The 'Weighted Average Cost of Capital' (WACC) can therefore be expressed as:

$$WACC = \alpha_E * r_E + \alpha_D * r_D * (1 - t) \quad (1)$$

where:

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1 Tariffs for regulated services charged to grid users, and therefore to energy consumers, typically also include other items, such as surcharges to fund the support of renewable energies or other activities of general interest, as well as duties and taxes.

2 Strictly speaking, depreciation measures the 'consumption' of an asset over time, as the asset is used during its economic life.

3 Depreciation may take different profiles over time (e.g., straight-line depreciation, in which the asset is depreciated at a constant rate over its economic life). The discussion of the possible depreciation profiles is beyond the scope of this Report.

- α_E and α_D are, respectively, the share of equity and the share of debt in the funding of the business, as recognised in regulation, with $\alpha_E + \alpha_D = 1$;
- r_E is the rate of return on equity deemed necessary to attract investors to the business;
- r_D is the rate of return on debt deemed necessary for the lenders to lend money to the business;
- t is the applicable corporate tax rate. Its inclusion in the formula recognises the fact that the interest paid on the debt capital is generally a deductible cost for tax purposes and therefore the actual cost of debt for the business needs to be reduced accordingly.

Most regulators in Europe adopt some form of incentive-based regulation to regulate network activities. Incentive-based regulation rests on the regulator setting the value of some of the regulatory parameters for a predefined, multi-year period, the so-called 'regulatory period'. The length of the regulatory period varies across jurisdictions, typically between three and eight years[4].

At the beginning of each regulatory period, regulators set the value and, possibly, the trajectory of some of the regulatory parameters over such a period. The incentive for the regulated undertaking to improve its efficiency stems from the fact that, if it is able to reduce its costs more than what the regulator expected and embedded into the trajectory of the allowed revenues, it could keep (a share of) the extra savings.

Even when fully-fledged incentive-based regulation is not used, regulators may still decide to predefine the level of some regulatory parameters for a period of time.

It is to be noted that, for what the allowed remuneration of capital is concerned, the incentivising properties of the approach outlined above do not depend on the value of the parameters in the WACC and on the way in which r_E and r_D are determined, but rather on the fact that these parameters are kept fixed within the regulatory period or vary in a way which is not linked to the actual strategies and performance of the regulated undertaking.

For example, the financial structure (α_D/α_E) used to determine the WACC for regulatory purposes does not need to reflect the one actually adopted by the individual network undertakings. As it will be further elaborated in Section 3.1.3, under incentive regulation, whatever the financial structure adopted by regulators to set the WACC, regulated undertakings would have an incentive to choose the financial structure which minimises their financing costs. In this sense, once this type of regulation has been in place for a few regulatory periods, one could expect that the regulated undertakings have adapted their financial structure towards an optimal one and therefore that the actual structure can also be used in determining the WACC for regulatory purposes. As it will be commented in Section 4.1. , this general conclusion might not hold for the Swedish energy network sector, since some of the regulated undertakings operating in this sector enjoy favourable

[4] In Great Britain, an eight-year regulatory period, as part of the RIIO-2 regulatory mechanism, is coming to an end.

financing conditions, which may affect the choice of the financial structure, but which are not available more generally across the sector.

What the values of the parameters and of the resulting WACC instead determine is the level of the allowed remuneration of the capital invested in the network business. As regulators are typically tasked with protecting current and future consumers, they should strike the right balance between guaranteeing, on the one hand, that current consumers do not pay more than what is strictly necessary for them to be provided with the network services that they require and, on the other hand, the economic and financial viability of an efficient network operator, so that the continuity of the business could be ensured to serve future consumers.

2. THE CURRENT AND PROSPECTED EI METHODOLOGY

On the basis of the documentation that we have been provided[5] and of interactions with Ei, we understand that Ei sets allowed revenues for Swedish gas and electricity network operators by implementing a revenue-cap methodology and four-year regulatory periods. As part of this methodology, the remuneration of the invested capital relies on:

- A WACC, expressed in real terms, to set the allowed rate of return, where the CAPM is used to determine the return on equity, in which:
  - The *beta* parameter[6] is set by looking at the *beta* parameters of comparable companies (hereinafter also referred to as "*comparables*") identified among EU gas/electricity transmission system operators (TSOs) and distribution system operators (DSOs). The main criteria for identifying comparable companies are:
    - at least 50% of the comparables' turnover shall be originated by electricity/gas transmission and/or distribution activities;
    - comparables shall be based in Europe and listed on a European stock exchange;
    - comparables shall have a minimum of 25% floating capital (shares of a company that can be publicly traded and are not restricted);
  - The cost of debt is determined as the risk-free rate augmented by a credit risk premium. The latter is determined looking at the cost of debt of companies with a credit rating of BBB, typical of comparable companies (used to set the *beta* parameter);
  - The debt-to-equity ratio employed to define the allowed WACC is determined looking at the capital structure of comparable companies (used to set the *beta* parameter);
  - The real rate of return is determined deducting consumer-price inflation from nominal rates of return observed on the financial markets.
- For electricity network operators, a replacement-cost methodology is used to set the RAV at the beginning of each regulatory period. Replacement costs for the different components of the network are determined by using unit price lists (UPLs), which are compiled on the basis of publicly-available price lists and of the actual investment costs incurred by regulated undertakings, available at the time when the price review is carried out. The RAV is then revalued on a yearly basis within the regulatory period, using a sector-specific inflation index (built mainly using construction costs).

[5] Energimarknadsinspektionen, Annexes 4 (Kalkylränta för tillsynsperioden 2023–2026) and 7 (Kalkylränta för tillsynsperioden 2024–2027) fo the revenue cap decisions for regulatory period 2024-2027 and 2023-2026..

[6] A definition of the *beta* parameter is provided in Section 3.2.1 below,

- For gas network operators, the RAV of each asset is determined at historical costs, and then revalued on a yearly basis employing a sector specific inflation indexed (built mainly using construction costs).

Ei is considering moving from the current methodologies to set the RAV to an alternative one, based on historical costs. In this context, Ei is also considering whether the new methodology to determine the allowed revenue to remunerate capital costs should be based on:

- a 'nominal-rate-of-return' approach. This approach combines a nominal allowed rate of return on capital with an unindexed RAV. In this approach, compensation for inflation is provided through the rate of return; or
- a 'real-rate-of-return' approach. This approach combines a real allowed rate of return on capital with an indexed RAV. In this approach, compensation for inflation is provided through the indexation of the RAV.

It is to be noted that both approaches could deliver the same net present value of the allowed revenues over the regulatory life of the assets as long as, in the real-rate-of-return approach, the same inflation index is used to determine the real allowed rate of return on capital from the nominal one and to index the RAV. However, the profile of the allowed revenues over time would be different in the two approaches.

3. ALTERNATIVE METHODOLOGIES TO SET THE ALLOWED RATE OF RETURN ON CAPITAL

There are some specific features of the Swedish energy network undertakings that make Ei question whether the CAPM is the most appropriate methodology for determining the cost of equity. Our understanding, based on the information provided by Ei, is that these specific features include:

- The ownership structure of the energy network undertakings: most of the regulated undertakings are publicly owned (by the central government or by municipalities). These undertakings have access to favourable financing conditions (e.g. municipalities have the possibility of borrowing from Interbank, a cooperative bank with an AAA rating and therefore able to borrow on the international financial markets at favourable rates);
- The capital structure of the energy network undertakings: the capital structure greatly differs among regulated undertakings; however, a considerable part of the Swedish regulated undertakings finance investments mostly through equity (very low debt-to-equity ratio, if compared to utilities at international level);
- The size of the energy network undertakings: distribution network companies are small (or very small) if compared with average DSOs at EU level.

Ei's concerns regarding the use of the CAPM to determine the cost of equity is linked to:

- The small number of available comparable companies to set the *beta* parameters and identify the benchmark capital structure (given the selection criteria set by Ei);
- The fact that the identified comparable companies greatly differ from Swedish network companies in terms of:
    - their ownership structure: comparables are quoted companies with significant floating capital;
    - their capital structure: on average, around 40% of the RAV of the comparables is financed through debt;
    - their size: comparables are large or very large operators;
    - their activities: some comparable companies carry out activities in unregulated sectors as well.

Furthermore, Ei is investigating whether the current cost of capital-setting methodology will be appropriate once the RAV-setting methodology is based on historical costs (instead of replacement costs).

In the following paragraphs we address each one of the above concerns and we assess alternatives to the current Ei methodology to set the allowed rate of return on capital.

3.1. Approaches to determine the allowed revenues to cover capital expenses

We believe it is useful to start by addressing some fundamental questions regarding the allowed revenues to cover capital expenses.

First, should regulation aim to allow the regulated undertakings to recover the costs of their investments over the economic lives of their assets ('backward-looking approach')? Or should it instead provide the regulated undertakings with the financial resources to replace the existing assets once they reach the end of their economic (or usable) lives ('forward-looking approach')?

Secondly, do regulators need to consider the capital structure, the ownership structure and the size of the regulated undertaking when setting the allowed rate of return on capital?

In the next two sub-sections, we address these questions in turn.

3.1.1. Backward-looking vs forward-looking regulation

In the backward-looking approach, regulation aims at:

- remunerating the regulated undertakings - and, therefore, their investors - for the financial resources invested in current assets;
- allowing the regulated undertakings to recover the funds invested in the assets of the regulated business, via allowed depreciation components, by the time that these assets have reached the end of their economic lives.

To value the RAV, this approach typically relies on:

- nominal historical cost, if the allowed cost of capital is expressed in nominal terms; or
- revalued historical costs (e.g. indexed to inflation), if the allowed cost of capital is expressed in real terms.

New assets, to replace the existing ones once they reach the end of their economic lives, will require new funds, which will again be recovered, including an appropriate rate of return, over the new assets' economic lives.

In the forward-looking approach, regulation aims at providing the regulated undertakings with the financial resources to replace the existing assets once they reach the end of their economic (or usable) lives.

To value the RAV, this approach typically relies on:

- a replacement costs methodology (e.g. employing up-to-date unit price lists (UPLs) derived from the current costs incurred by regulated undertakings); or
- revalued historical costs, using a sector specific inflation index (that should capture the price changes over time for the specific goods and services used to perform the regulated service).

However, the forward-looking approach is unlikely to ensure funding for the new assets to replace existing assets at the end of their economic lives, since:

- depreciation over the economic lives of existing assets is typically based on the replacement values of these assets over that period, and not only at the time when they need to be replaced (at the end of their economic lives);
- the assets that the regulated business requires at the end of the economic lives of the existing assets might be different in kind (due to technological development) from the latter, on which the remuneration is based.

In a static world, with no inflation or technological development, the backward- and forward-looking approaches would coincide, as the cost of replacing the assets at the end of their economic lives would be equal to the value of the existing assets when they were included in the RAB. However, in a non-static world, the two types of approaches have different implications.

The most relevant implication is that forward-looking approaches are likely to impose a higher risk of under-remuneration (or over-remuneration) on the investors in regulated undertakings, which might, as a result, require a higher rate of return on investments. This is because:

- a rate of change in replacement costs which is lower than the rate of inflation used to determine the real allowed rate of return (typically Consumer Price Indexes) leads to the business not achieving the expected remuneration;
- on the contrary, if the rate of change in replacement costs is higher than the rate of inflation used to determine the allowed real rate of return, investors enjoy an over-remuneration of their investment[7].

3.1.2. Allowed remuneration and the ownership structure of regulated undertakings

Best regulatory practice suggests that the allowed remuneration of the regulated business should be independent from the ownership structure of the regulated undertaking. This is based on the principle that regulation should focus on the features of the regulated business and not on the features of the regulated undertaking, including its ownership. Setting the allowed remuneration independently of the ownership structure of the regulated undertaking also avoids that the level of remuneration, and therefore tariffs charged to consumers, changes as a result of changes in the ownership structure, for example as a result of privatisation[8].

The great majority of EU regulators set the allowed cost of equity and debt of energy network undertakings by relying on market analysis that look at other companies that are comparable in terms of risk, irrespective of their ownership

[7] In fact, as mentioned in the text, the nominal rate or return (NRoR) and real rate of return (RRoR) approaches deliver the same proper remuneration (that is the one deemed efficient by the regulator) and capital cost recovery as long as, in the RRoR, the same inflation rate is used to: i) determine the real rate of return (subtracting inflation from the nominal rate of return), and ii) revaluate the asset values. The same equivalence does not hold if the revaluation of the RAV in the RRoR approach is done by using replacement costs. In fact, replacement costs typically follow different dynamics from the rate of inflation used to determine the real rate of return (typically a consumer price index).

[8] Which has been observed in some jurisdictions, but it was due to the fact that governments wanted to maximise the sale value of the State-owned companies. This was therefore not justified by best regulatory practice.

structure. Therefore, whatever the ownership structure of the undertakings to be regulated, comparable companies used as references for setting regulatory parameters should be chosen among those which are privately owned and subject to market discipline in their financing[9].

For example, in Germany where electricity and gas DSOs are typically owned (and controlled) by municipalities or other public entities[10], the energy regulator sets the equity risk premium taking into account: "*conditions on the national and international capital markets and the valuation of operators of gas supply networks on these markets*" and "*average return on equity for operators of gas supply networks on foreign markets*"[11]. The focus of the regulator is on the activity carried on by comparables companies and not on their ownership structure.

The same holds in Italy, where most regulated undertakings are controlled or participated by public entities (at national or municipal level) and the regulator identifies comparable companies to set the cost of equity not considering the ownership structure as a relevant criterion[12]. Annex A illustrates the criteria used to identify the comparables by ARERA, the Italian network regulator.

If a publicly-owned regulated undertaking enjoys lower financing costs, this should be attributable to the ownership structure and not to the regulated business' characteristics, and the benefits (e.g. in terms of higher margins) should accrue to the owners (i.e. the citizens). It is in fact society as a whole, through public ownership, which provides the greater guarantee, and absorbs the risk, which allows access to better financing conditions and it should be society as whole, and not the regulated undertaking's customers, to benefit from it.

It is however also worth mentioning a study recently published by the Performance Review Body of the Single European Sky (PRB), an advisory body to the European Commission, on the allowed cost of capital for air navigation service providers (ANSPs)[13]. The PRB study states that, being ANSPs 100% publicly owned:

- an "Efficient WACC" based on a standard WACC/CAPM methodology - relying on comparable companies at international level to set the cost of equity and the cost of capital – should be used as the default option;
- an "Administered WACC" should however be used - if lower than the Efficient one - for an ANSP that is "*subject to a government-specified equity return*". The

[9] Once the set of comparable companies has been identified, the regulator could refer to the best-performing companies in such a set, or to an average performance of such companies. This is a discretionary choice for the regulator to make and depends on the regulator's assessment of the speed with which the undertakings to be regulated are able to improve their performance (e.g. in terms of efficiency or financing strategy). A possible course of action for the regulator could be initially to refer to the average performance of the comparable companies, shifting its focus, over time, towards the best-performing ones. However, to the extent that the comparable companies are also subject to incentive-regulation, one could expect that they will also increase their performance over time, which would imply that even focusing on the average performance of the set would already incorporate an increase in absolute performance.

[10] See, for example, KPMG and Bocconi University (2018).

[11] Bundesnetzagentur, „Beschlusskammer 4, Beschluss BK4-21-0.56", 12 October 2021.

[12] Autorità di Regolazione per Energia Reti e Ambiente, Consultation document 342/2024/R/com regarding the update of the allowed WACC for the sub-period 2025-2027.

[13] See PRB (2024).

Administered WACC is based on "*rate specified by the government*" (to set the cost of equity) and on "*genuine Cost of Debt or government borrowing rate (whichever is higher)*";

- an "Hybrid WACC", should instead be used - if lower than the Efficient one - when "*the WACC of an ANSP comprises loan finance on favourable terms but is not subject to a government-specified equity return*". In this case, the CAPM is used to set the allowed cost of equity, while the cost of debt is based on "*genuine Cost of Debt or government borrowing rate (whichever higher)*".

Therefore, the PRB does consider the possibility to lower the allowed cost of capital – if compared with the "efficient" one - when:

- the government specifies the rate of return for the regulated undertaking; or
- public entities' ownership allows better conditions in accessing credit.

However, some of the stakeholders involved in the process that led to the PRB study (including an independent regulator such as the UK Civil Aviation Authority) supported the principle of irrelevance of ownership in determining the allowed cost of capital, as well as arguing that the actual financial structure and the actual organisational structure are not relevant for the calculation of an efficient cost of capital[14].

Furthermore, we are not aware or any other public body or regulator that adopts different methodologies to calculate the allowed cost of capital depending on the ownership structure of the regulated undertakings. Moreover, the public owner of a regulated undertaking might have other (political and social) objectives than profit maximisation (and economic efficiency).

Finally, the academic literature looking at the relationship between allowed returns of regulated undertakings and their ownership structure suggests that there might be a relationship between ownership structure and the allowed revenue provided by the regulator to the regulated undertakings - see Annex B for further details. In practice, there is some evidence that privately-owned regulated undertakings might achieve a higher allowed remuneration. According to several scholars, this is likely to be the result of:

- a more aggressive lobbying vis-à-vis the regulatory authority and some degree of regulatory capture;
- a higher leverage of privately-owned regulated companies and the pressure that this might put on the regulator to provide higher allowed returns to avoid companies' financial distress;
- the fact that publicly-owned undertakings might have other objectives than profit maximisation, which typically characterises privately-owned undertakings;

but none of these aspects has much to do with best regulatory practice.

[14] See Steer Davies Gleave (2014).

3.1.3. Allowed remuneration and the capital structure of regulated undertakings

Best regulatory practice suggests that the allowed remuneration should be independent of the actual capital structure of the regulated undertaking. In fact, setting regulatory remuneration based on the actual capital structure of a regulated undertaking might distort its funding choices (e.g. promoting a lower-than-efficient debt/equity ratio in case equity capital were attracting higher remuneration[15]).

Therefore, regulatory authorities typically identify a reasonable notional capital structure (possibly on the basis of the sector average[16]) and set the allowed remuneration on the basis of that structure. As mentioned in Section 1 above, the incentivising properties of a predefined capital structure used for regulatory purposes is independent from the chosen structure. What matters is that the structure used for regulatory purposes is not regularly adjusted to reflect the actual one.

Regulated undertakings should then be allowed to:

- opt for the most efficient capital structure, possibly within precautionary limits set by the regulatory authorities; and
- benefit, at least for a (regulatory) period from the lower financing cost of a more efficient capital structure than the reference one chosen by the regulatory authority.

In this regard, the capital structure could be dealt with in the same way as other parameters (e.g. OPEX) within an incentive-based regulatory framework.

3.1.4. Allowed remuneration and the size of regulated undertakings

As detailed in the following Section 3.2.1, evidence shows that the CAPM does not always perform well (or as well as it could) in assessing the risk premium of smaller companies.

In fact, historically, average returns on stocks of firms with a low market capitalisation (typically smaller companies) have been higher than predicted by the CAPM.

This "size effect" was first detailed by (Banz, 1981)[17]: the average return of smaller companies appears high relative to the returns of larger firms, even when

[15] Regulated activities generally require both debt and equity finance in order to support investments. Raising debt can be a cost-efficient way of financing, as interest rates are typically lower than the cost of equity (everything else being equal, debt holders rank before equity holders, so in normal circumstances, it is reasonable to assume a lower return on debt than on equity). This is also reinforced by fiscal benefits, as corporation tax is paid on earnings after interest. However, increased gearing also increases financial risk, as the proportion of an entity's revenues that are committed to the repayment of debt becomes higher. At higher levels of gearing, the probability of bankruptcy may be a significant concern, and lenders may demand a higher interest.

[16] Provided that the regulatory framework does not incentivise undertakings to opt for a sub-optimal capital structure.

[17] See also the next Section 3.2 regarding the CAPM and the Three-Factor Model (Fama-French, 1996).

accounting for market risk as implied by the CAPM framework. Instead, for larger companies, the "standard" CAPM framework tends to work reasonably well[18].

In general, regulators do not add small-company premia to the cost of capital. This may depend on the fact that regulated undertakings are normally not that small.

In the past, some regulators have allowed small-company premia (e.g. Ofgem, Ofwat, Oftel and NIAUR in the UK). However, the equity *beta* for small companies is generally difficult to observe or estimate because such companies tend not to be listed. The small-company premium has therefore to be estimated referring to comparable companies that may be active in sectors other than the one being regulated (assuming the CAPM is employed)[19].

However, if literature and regulators have focused on how to identify and assess the higher cost of capital for smaller companies, it appears that this may be less relevant in the Swedish energy network sector, where some small regulated undertakings can access equity and debt at favourable conditions, if compared with large privately-owned companies.

Furthermore, other things being equal, a small-company premium may weaken the incentive, for small company, to reach the minimum efficient size to exploit economies of scale (achievable, for example, through mergers between small companies).

3.2. Cost of Equity

There are, in theory, several different methods to value the cost of equity. The different methods have their own advantages and disadvantages, which should be taken into account when considering their ability to be systematically used in the regulatory practice for setting the allowed rate of return on capital. In this section, we outline and assess the main theoretical models for determining the cost of equity:

- the Capital Asset Pricing Model - CAPM (Sharpe, 1964) and (Lintner, 1965);
- Multi-factor pricing models:
  - the Arbitrage Pricing Theory (Ross, 1976);
  - the Three-Factor Model (Fama & French, 1995);
- Extensions to the CAPM:
  - the Intertemporal CAPM (Merton, 1973);
  - the Consumption CAPM (Breeden, 1979);
- the Dividend Discounted Model and the Discounted Growth Model (Gordon & Shapiro, 1956).

[18] See, for example Brealey, *et.al* (2023)

[19] See, for example: London Economics (2010)

Furthermore, we outline some simplified models which are less theoretically robust, but are sometimes used in practice to assess the cost of equity in corporate finance, such as:

- Risk premium approaches (cost of debt + risk premium); and
- Build-up methods (bond yields + risk premium).

3.2.1. Capital Asset Pricing Model (CAPM)

The CAPM defines the rate of return on equity as:

$$\boldsymbol{r = r_f + \beta\,(r_M - r_f)} \qquad (2)$$

where:

- r is the return on equity;
- r_f is the risk-free rate;
- β (*beta*) is a measure of the exposure of the equity to market risk, calculated as the covariance between the return of a given stock and the market return divided by the variance of the market return;
- r_M is the market return.

The CAPM is one of the most widely used models for estimating the rate of return on equity, and relies on the following well-funded arguments:

- the only risk that investors are concerned about, and therefore should be rewarded for, is market risk (and not the activity-specific risk, which can be diversified away)[20]. Therefore, the risk premium should be proportional to the exposure of the equity to market risk;
- the expected rate of return equals the risk-free interest rate plus a risk premium;
- the expected risk premium offered by a stock equals its *beta* multiplied by the expected market risk premium;
- stocks are priced to offer expected risk premia that are proportional to *beta*.

However, the CAPM is based on the following assumptions:

- investors choose their portfolios based on expected return and risk, measured by the variance of returns;
- all investors have the same estimates of expected returns and risks of all assets;
- investors trade in perfect capital markets (no taxes or transaction costs) and investors can both borrow and lend at the same risk-free rate;
- Investors are price-takers and cannot influence prices.

[20] The CAPM is based on the following assumption: the risk of any stock can be broken down into the specific or diversifiable risk that is peculiar to that stock, and the systematic or market risk from market-wide fluctuations. Investors can eliminate specific risk by holding a well-diversified portfolio, but they cannot eliminate market risk. The full risk of a fully diversified portfolio is market risk.

These assumptions hardly all apply simultaneously in the real world. Nevertheless, the CAPM "works" in several important respects and generates sensible estimates of the cost of equity[21]. However, historically:

- the average returns on high-*beta* stocks have been lower than predicted by the CAPM;
- average returns on small-capitalisation[22] and value stocks[23] have been more than predicted by the CAPM.

3.2.2. Arbitrage Pricing Theory (APT)

The CAPM argues that the only risk that investors are concerned about is market risk and that only one measure of risk (*beta*) is needed. Instead, the Arbitrage Pricing Theory (ATP) starts by assuming that each stock's risk premium depends on external macroeconomic factors.

The APT agrees with the CAPM that there are two sources of risk for an individual stock:

- the risks specific to the company. Since specific risk can be eliminated by diversification, it should not affect a stock's risk premium;
- the systematic risk that determines the expected (and required) risk premia.

However, unlike the CAPM - that argues that there is only one source of systematic risk, which is the stock's exposure to the risk of the market portfolio – the ATP claims that systematic risk may stem from multiple macroeconomic factors. These systematic "macroeconomic" risks cannot be eliminated by diversification and, therefore, generate expectations in term of risk premia.

Therefore, the APT states that the expected risk premium on a stock depends on the expected risk premia associated with the different macroeconomic factors and the stock's sensitivity to such factors.

The APT formula is therefore:

$$\boldsymbol{r = r_f + r_p} \tag{3}$$

with r_p being:

$$\boldsymbol{r_p = b1\left(r_{factor1} - r_f\right) + b2\left(r_{factor2} - r_f\right) + \cdots} \tag{4}$$

where:

- r is the return on the equity;
- r_f is the risk-free rate;
- r_p is the risk premium;

[21] See, in this regard: Brealey *et.al* (2023)

[22] Small-capitalisation stocks are stocks of firms with a low market capitalisation (typically smaller companies).

[23] Value stocks are those with high ratios of book value to market value.

- $b1$, $b2$, … are the stock's sensitivities to the different macroeconomic factors (1, 2, …);
- $r_{factor1}$, $r_{factor2}$,… are the returns associated with the different macroeconomic factors (1, 2, …).

The APT model is founded on the following assumptions:

- Investors are risk-averse in nature and they all possess the same expectations;
- Efficient markets with limited opportunity for arbitrage;
- Perfect capital markets;
- Infinite number of assets;
- Risk factors are indicative of systematic risks that cannot be diversified away and thus impact all financial assets, to some degree. Therefore, these factors must be:
  - non-specific to any individual firm or industry;
  - compensated by the market via a risk premium.

The APT does not indicate which are the underlying risk factors. Some stocks may be more sensitive to a particular risk factor than other stocks (e.g. an oil company may be more exposed to the "oil price factor"). The risk associated with (the variability of) the return on the market portfolio (as for the CAPM) might be one factor, but then again it might not.

The choice of the factors will therefore strongly condition the results of the ATP in terms of expected market premia. And the use of ATP carries the risk of taking into account non-systematic risks (if, for example, a chosen macroeconomic factor does not impact all financial assets and, therefore, could be diversified away).

The difficulty in selecting the right macroeconomic factors is widely recognised: "*One way to use the APT in practice is to try out plausible factors to see which candidates seem to explain past stock returns. The danger with that approach is that some of these factors will end up significant by chance—their correlation with returns is spurious. If so, investors don't actually require a risk premium for exposure to those factors, and the factors will not predict future returns reliably*"[24].

3.2.3. Three-Factor Model

The Three-Factor Model retains the basics of the CAPM methodology but adds two more factors to explain variations in the return on equity, as for example already referred to in Section 3.1.4.

There is a significant literature identifying anomalies that cannot be explained by the CAPM[25]. These anomalies represent factors beyond market risk that have been found to be related to equity returns. Fama and French (1996) found that firm size and book-to-market value consistently have high explanatory power in

[24] Brealey *et.al* (2023), pag.238.

[25] See, for example: Roll (1977) and Black, (1993).

estimating the return on equity and that incorporating these factors eliminates a wide range of other anomalies that are encountered by using the CAPM[26].

The general formula of the Three-Factor Model is:

$$\boldsymbol{r = r_f + \beta\left(r_M - r_f\right) + s\,SMB + h\,HML} \qquad (5)$$

where:

- r, r_f, r_M and $\boldsymbol{\beta}$ are all defined as per the CAPM;
- SMB is the size premium, constructed as the difference between the returns of portfolios of small and large firms;
- HML is the value premium, constructed as the difference between the returns for portfolios of firms with high and low book-to-market value ratios;
- *s* and *h* measure the sensitivity of the firm's returns to the SMB and HML factors.

The Three-Factor Model results in cost of equity estimates that are consistent with market expectations. However, the model introduces two additional factors, the size and the value terms, which makes it more complicated to apply in practice. It is also not clear whether the approach is consistent with the CAPM assumptions as the size or value factors may include some specific risk.

This Three-Factor Model is not widely used in practice to estimate a company's cost of equity: "*The model requires three betas and three risk premiums instead of one beta and one market risk premium in the CAPM. Also the three Fama–French betas are not as easy to predict and interpret as the CAPM beta, which measures market risk, and there's a logical reason for why investors should be compensated for bearing market risk. The logic for using Fama–French risk factors is sometimes elusive*"[27].

Finally, for regulated companies, which are often of medium size and high book-to-market value, the Fama-French Three-Factor Model could provide higher estimates of the cost of capital, as investors require higher returns on capital to invest in companies with high book-to-market ratios, according to the model. For example, for the UK electricity distribution companies in 2006, the maximum effect of size and book-to-market value was estimated at +1.25%[28].

3.2.4. Extensions to the CAPM

Intertemporal CAPM

In the standard CAPM, investors are only concerned about the return on their investment at the end of the considered period: CAPM is a single-period model, which means that it does not account for changes in risk and expected returns over

[26] See Smithers and Co. (2003)

[27] Brealey *et al.* (2023), pag.240.

[28] See Smithers and Co. (2006)

time. The CAPM application involves estimating *beta*s and analysing market risk factors over a defined limited time frame.

In 1973, Merton[29] reformulated the CAPM over multiple periods, known as the Intertemporal CAPM (ICAPM). In Merton's ICAPM, investors care both about their end-of-period payoff, as well as about the opportunities to consume or invest the payoff. Consequently, investors are concerned about how their future wealth may vary with macroeconomic variables such as labour income, the prices of consumption goods, and expectations for the former and the latter in future time periods. Unlike the CAPM, current demand for assets is "*affected by the possibility of uncertain changes in future investment opportunities*".

As with the CAPM, investors in the ICAPM aim at maximising their return for a given risk (or, equivalently, minimising risk for any given return). In addition, however, investors in the ICAPM are concerned with how the portfolio returns co-vary with the macroeconomic variables. Consequently, the optimal portfolio must be multifactor-efficient, which requires optimising the expected return for a given return variance and covariance between return and macroeconomic variables.

However, as for the ATP, the ICAPM does not identify the macroeconomic variables that constitute intertemporal risks or the relative importance of these intertemporal risks. Furthermore, ICAPM covers multiple time periods, so multiple *beta* coefficients are required. This makes the model difficult to apply in practice.

Consumption CAPM

Multifactor models, such as the ATP and the ICAPM, attempt to improve the empirical performance of the CAPM by identifying factors, in addition to market risk, that explain the return of a stock or portfolio. However, these models do not provide any selection of these factors.

Consumption CAPM (CCAPM) provides a way of reducing all of these other factors into one variable: consumption[30]. CCAPM does not assume portfolio-value maximisation, but rather consumption maximisation, where the buying and selling of assets is used to maximise consumption over time. Unlike the CAPM which measures the risk of an asset as the exposure of its return to market risk, in the CCAPM the risk premium is measured by the covariance of its return with economy-wide consumption, as a proxy for the stage in the economic cycle.

Assets whose return is high when consumption is high (and marginal utility of consumption is low) are riskier, and therefore less desirable to hold. On the other hand, assets that have a negative covariance with consumption attract a lower risk premium. Therefore, the asset's systematic risk is associated with the state of the economy (consumption).

The benefit of this approach is that it provides the most general theory of risk, which encapsulates all risk: the risk of future consumption. However, its application to real-world analysis is difficult: consumption data, upon which this model relies, is

[29] See Merton (1973)

[30] See Breeden (1979)

difficult to source, it provides no specification of investors' utility and it relies on the rationality of individual investors[31].

3.2.5. Discounted Dividend Model (DDM) and Discount Growth Model (DGM)

The Discounted Dividend Model (DDM) assumes that the value of a stock is based on the expected dividends in the future. Depending on the maturity of the company, the DDM model can be adapted to cover several different growth phases of companies (e.g. growing vs. mature businesses), by employing different levels of expected dividends in the future[32].

The DDM formula is:

$$\boldsymbol{P_0 = \sum_{t=1}^{\infty} \frac{DIV_t}{(1+r)^t}} \quad (6)$$

where

- P_0 is today's stock price;
- DIV_t is the expected dividend per share at a future date t;
- r is the discount rate which is equal to the expected return on equity.

The Gordon Discount Growth Model (DGM) is a version of the DDM which may be fit for mature and stable companies that regularly pay dividends: it assumes a constant growth rate for company's dividends. This does not preclude year-to-year deviations from the forecast. It means only that expected dividends grow, on average, at a constant rate.

The Discount Grow Model formula is:

$$\boldsymbol{P_0 = \frac{DIV_1}{r-g} \rightarrow r = \frac{DIV_1}{P_0} + g} \quad (7)$$

where:

- DIV_1 is the first year dividend;
- r is the discount rate which is equal to the expected return on equity;
- g is the growth rate of the dividend in the future.

Knowing:

- the current market price of the stock;
- the expected next year dividend; and

[31] See IPART (2009)

[32] See Brealey *et al.* (2023)

- the growth rate of the dividend in the future;

it is possible to derive the return on equity expected by the market.

However:

- If employed to determine the allowed regulatory cost of capital, both DDM and DGM introduce an element of "circularity": the cost of capital depends on the expected future dividends, which depend themselves on future allowed revenues, which are affected by the allowed cost of capital determined by the regulator;
- In the case of a non-publicly traded company, it may be difficult to estimate the current market price of the company;
- The discounted dividend models ignore other factors that may impact the value of the company (e.g. market conditions) and are sensitive to assumptions on dividend's growth rates.

3.2.6. Risk Premium Approach

A simplified version of the CAPM, the so-called Risk Premium Approach, collapses the *beta* and the risk premium into one figure and adds this figure to the return on a selected debt instrument. The debt instrument is either government bonds or utility bonds.

The Risk Premium Approach formula is:

$$\boldsymbol{r = r_d + ERP} \tag{8}$$

where:

- r is the return on equity;
- r_d is the return on a selected debt instrument;
- ERP is the estimated risk premium.

There are many versions of this model depending on the choice of the debt instrument and the estimation of the risk premium. The Risk Premium Approach may be implemented using either a historical estimate of the risk premium, or a forward-looking or expected risk premium.

The historical risk premium is determined as the historical spread between equity and debt returns, so the primary choices for the analyst become which equity return and debt instrument to use, as well as the period over which the spread is to be measured.

This model could be implemented by regulators using long-term government bonds or utility/corporate bonds to measure the cost of debt, while the equity investment returns used may be either:

- realised accounting returns of regulated entities in the same industry; or
- realised stock returns of companies in the same industry (or with the same risk profile).

It is important to note here that the Risk Premium approach, while a generalised form of the CAPM, does not have the same level of theoretical support as the standard CAPM. This is because the return on the selected debt instrument used is not necessarily equal to the risk-free rate, and the estimated risk premium used is not explicitly based upon the product of the market *beta* and the market risk premium.

3.2.7. Build-up Method

The Build-up Method formula is:

$$\boldsymbol{r = r_f + MRP + SMB + IP + \cdots} \tag{9}$$

where:

- r is the return on equity;
- r_f is the risk-free rate;
- MRP is the market risk premium;
- SMB is the small-size premium;
- IP is the industry premium.

The Build-up Method estimates the return on equity as the sum of a risk-free rate and one or more risk premia that represent the rewards an investor receives for taking on a specific risk.

- The components of the Build-up Method are[33]:
  - the risk-free rate;
  - the market risk premium, reflecting the compensation above the return on a risk-free asset that investors require for the additional market risk they bear by investing in a well-diversified market portfolio of risky assets;
  - the small-size premium, which may be included to account for the additional risk inherent in small-company stocks;
  - an industry premium, which can be determined based on the characteristics of the industry;
  - potentially other factors. Some argue for the inclusion of minority discount premia, control premia, key person discount, *etc.*

The Build-up Method does not have the same level of theoretical support as other methods (such as the CAPM, APT and DGM) and does not provide unambiguous guidance on how to evaluate different premia. In general, this model suffers from issues of data unavailability, overfitting and a lack of clear economic logic.

[33] See Morningstar (2012)

3.2.8. Comparison between alternative methodologies to set the allowed cost of equity

In this section we compare the alternative methodologies to set the cost of equity described above, considering their applicability in the context of the economic regulation of networks.

The CAPM has some empirical shortcomings - mostly regarding its inaccuracy in explaining the cost of capital of small and high book-to-value enterprises - but has sound theoretical foundations and is widely used.

Certainly, the use of the CAPM presents some implementation issues and regulators must exert some discretion, mostly regarding the setting of:

- The risk-free parameter (r_f): judgment is required in identifying the right proxy of the risk-free rate for the relevant market. In this respect, most regulators refer to highly-rated government bonds.
- The market return parameter (r_M): This is typically derived from three approaches:
  - "Historical ex-post" approaches use observed historical equity returns as a benchmark for investors' current expectations for the market return;
  - "Historical ex-ante" approaches also use observed historical returns to infer the expected market return, but adjust them for historical factors which are unlikely to be repeated; and
  - "Forward-looking'" approaches use more recent market data, such as current market valuations, and/or surveys of market practitioners to infer the expected rate of return on the market index.

  Most regulators place weight on historical ex-post approaches and many of them on historical ex-ante methods. Some regulators have also considered forward-looking evidence in their most recent decisions[34].
- The *beta* parameter: the most common technique to estimate equity *betas* is a regression analysis of past returns on the listed stock(s) of interest and the market index. However, some discretion must be exerted in:
  - identifying listed companies which could form suitable comparables for the regulated activities. In practice, there are very few listed companies that are subject to the same level of risk (considering the relevant regulatory framework) and that are engaged only in the same regulated activities (so called pure-player).
  - estimating raw equity *betas* for these comparators, typically using a range of estimation periods and a range of returns data (e.g. daily, weekly or monthly);
  - de-leveraging raw equity betas to obtain a measure of risk not affected by the capital structure, typically relying on comparables' gearing;

[34] See UKRN (2022)

- re-leveraging the asset *beta* using the regulator's assumptions for the notional gearing for the relevant notional company[35].

However, most investors are familiar with the CAPM and understand its use in regulatory practice.

Multi-factor models - such as the ATP, the Three-Factor Model and the ICAPM - propose additional factors, beyond market risk, in order to overcome some of the main empirical shortcomings of the CAPM. However:

- the ATP and the ICAPM do not indicate what are the additional factors. The choice of the factors could strongly influence the results in term of expected market premia. The wrong choice of factors could result in allowing market premia for some specific, and therefore diversifiable risk;
- the Three-Factor Model introduces two additional factors, which makes less clear whether the approach is consistent with the CAPM assumptions as the size or value terms may include some specific risk.

Moreover, multi-factor models may be difficult to implement because of the difficulty to source and elaborate data to value the sensitivity of stock to the different identified factors. The same holds for the CCAPM: consumption data, upon which this model relies, is difficult to source and use to derive the investor's utility function.

Similarly to the CAPM, the DDM and the DGM have sound theoretical foundations and are widely used in corporate finance. Furthermore, they are very intuitive and simple methods. Nevertheless, even if data on future dividends were available (that is not always the case for non-publicly listed companies) the use of the DDM and of the DGM for regulatory purposes may be inappropriate: If employed to determine the allowed rate of return on capital, both DDM and DGM introduce an element of "circularity".

Risk Premium Approaches and the Build-up Method do not have the same level of theoretical support as other methods and do not provide unambiguous guidance on how to evaluate different premia. Furthermore, these models suffer from issues of data availability and overfitting.

Finally, all alternatives to the CAPM do not allow to overcome the main critical implementation issue of the CAPM, namely the difficulty in identifying the correct comparables.

In fact:

- multi-factor methodologies rely on financial market data to value the sensitivity of stocks to each factor;
- the DDM and the DGM may be employed looking at regulated undertakings, however, if regulated undertakings are not publicly-listed companies, it could be difficult to value their shares: looking at listed comparable companies may be the only way to overcome this issue;

[35] See, for example: UKRN (2022)

- in the Risk Premium Approaches and the Build-up Method, risk premia should be evaluated looking at expected premia on the market for assets with the same level of risk.

Setting the criteria to identify comparable companies is a very sensitive matter in the context of regulatory practice. Some discretion must be exercised, thus making regulator's decisions debatable from the regulated undertakings' point of view. However, regulators could rely on international best practices in order to identify the right criteria for identifying comparable companies (see Annex A for an overview of typically employed criteria).

In the following table we illustrate the benefits and drawbacks of the methodologies to set the allowed rate of return on capital considered in this section.

Table 1 *Comparison between the main theoretical models for determining the cost of equity*

Methodology	Benefits	Drawbacks
Capital Asset Pricing Model (CAPM)	• Widely accepted, used and supported by theory • Simplicity of implementation • Allow to compare different companies/ activities/sector	• Assumptions in the model do not always apply in the real world • Identifying comparables may be challenging
Arbitrage Pricing Theory (APT)	• Flexibility • Allows to take into account additional factors whose relevance may be underestimated by the CAPM • Supported by theory	• Identifying relevant factors may be difficult • Larger amount of data to process • Rarely used in practice • Identifying comparables may be challenging
Three-Factor Model	• Takes into account additional factors that are underestimated by the CAPM (small company and low-value stocks)	• The additional factors may include some specific risk • Not as easy to implement as the CAPM • Rarely used in practice • Identifying comparables may be challenging
Extensions to the CAPM	• May overcome flaws of the CAPM	• Difficult to implement • Not used in practice
Dividend Discounted Model and Discounted Grow Model	• Flexible • Easy to implement (if data is available) • Forward looking approach	• May introduce circularity if used to set the allowed cost of equity • Dividend growth in mostly non-linear in real world • Identifying comparables may be challenging
Simplified models: **Build-up Method and Risk Premium Approaches**	• May be easy to implement	• Not supported by theory • Identifying comparables may be challenging

3.3. Cost of Debt

Unlike the cost of equity, the actual cost of debt of a company can be directly observed and derived from both:

- financial statements, looking at the interest expenses and debt balances of single companies; and
- financial market data, for example, looking at the returns required by investors on companies' bonds (different sector-specific indexes on the cost of debt are also available).

However, to estimate the forthcoming cost of debt of a company (or a sector) may be challenging because evolving market conditions may result in changes in the interest rates on debt instruments, and changes are not always accurately predictable by financial markets.

This has different implication, for regulators, in determining the allowed cost of debt:

- the cost of embedded debt (e.g. the debt contracted before the start of a given regulatory period) may change over time depending on whether the debt has been contracted at fixed or floating rates;
- the new debt that the company contracts during a given regulatory period may have a different cost than the one set by the regulator (which was based on the prevailing market conditions at the time when the decision on the allowed revenues was taken).

An allowed cost of debt which is higher than the actual (efficient) cost of debt[36], during a given regulatory period, would result in network users being overcharged. On the other hand, an allowed cost of debt which is lower than the actual efficient one may hinder the financing of new investments and lower the rate of return on current investments, making the regulated sector less attractive to investors.

Therefore, setting the allowed cost of debt is not only a matter of finding the right balance in the usual trade-off between attracting investment in the sector and protecting current and future consumers, but also to allocate, among regulated undertakings and network users, the risk of changes in the cost of debt during the regulatory period.

In this regard, regulators take different approaches to setting the allowed cost of debt[37]. Different approaches reflect differences in the desired risk allocation. The main differences typically relate to:

- the indexation of the debt costs to evolving market conditions; different options may be considered:
    - the pass-through of actual costs: the allowed cost of debt equals the actual cost incurred by regulated entities. In this case increases

[36] The cost of debt deemed efficient by the regulator, considering prevailing market conditions (e.g., in term of interest rates and inflation), the riskiness of the activity (that may impact on the rates required by lenders) and the possibility for regulated undertaking to refinance the embedded debt.

[37] For a detailed review of the main methodologies used by European regulators see, for example CEPA (2023).

(decreases) in the cost of debt during the regulatory period would be entirely suffered (enjoyed) by network users. A pass-through regime transfers the risk from the regulated undertakings to network users; however, no incentive to cost reduction and to increasing financing efficiency is placed on the regulated undertakings.

- fixed *ex-ante* allowance: the whole risk would be allocated to regulated undertakings that would have to absorb any change in the cost of debt during the regulatory period. On the other hand, a fixed allowance provides an incentive for regulated undertakings to minimise the cost of procuring debt capital.
- adjustment mechanisms during the regulatory period: the allowed cost of debt capital is periodically updated to reflect the evolving market conditions. In some cases, adjustments are provided for only if changes in market conditions result in a significant impact on the cost of debt (the so called "trigger-mechanisms" provide a minimum threshold that triggers the adjustment in the cost of debt allowance). However, the allowed cost of debt remains fixed between one adjustment and the following one. This provides incentives for regulated undertakings to minimise the cost of debt, while still protect them from major changes in the debt market conditions.

- the period over which the cost of debt is fixed or its evolution predetermined. The length of this period impacts the allocation of risk, as it conditions the frequency of adjustment of the allowed cost of debt.

Furthermore, different approaches regarding the valuation of the allowed cost of debt may be employed. The main differences may relate to:

- forward-looking vs. backward-looking approaches. Regulators may rely on:
  - historical costs to determine the cost of debt; two estimation approaches are typically used[38]:
    - balance sheet approaches: using debt instruments issued by regulated companies to define the notional efficient benchmark, typically employing sector average values;
    - benchmark index approaches: using external market indices with broadly similar credit ratings to the notional company to define the notional efficient cost of debt;
  - forward-looking evidence, for example, both Ofgem (UK) and ARERA (Italy) calculates the cost of debt allowance with reference to the yield of the iBoxx Utilities 10yr+ index.

  The choice between the two approaches may be related to the methodology used to index the allowed debt costs to evolving market conditions: if the cost of debt allowance is fixed ex-ante for the entire regulatory period, regulators may want to rely more on forward-looking evidence. Furthermore, the choice

[38] See UK Regulators Network (UKRN) (2023).

may depend also on the availability of consistent (historical and/or forward-looking) data.

- the treatment of embedded and new debt: some regulators recognise a distinction between the costs of embedded and new debt. In this case, typically the cost of embedded debt is estimated relying (more) on historical data; while the new debt is estimated looking at more contemporaneous and forward-looking data. Once again the choice may depend also on the availability of consistent (historical and/or forward-looking) data.
- the criteria to identify companies or benchmark indexes used to determine the cost of debt: benchmark companies or indexes could be more or less comparable, for example in term of regulatory regime (and therefore underlying risk profile) and credit rating. In this regard, the UK Regulators Network recognises that: "*the cost of debt is an area where it is reasonable for regulators to take different approaches, because the circumstances across the various sectors can be very different. For sectors with multiple regulated companies, an approach where the notional allowance is based on a benchmark drawn from sector average balance sheet costs and/or a benchmark index is likely to be reasonable in most circumstances. In sectors with one regulated company, it would also be reasonable to consider suitable benchmarks, potentially as cross-checks to provide assurance that actual debt has been prudently incurred*"[39].
- depth of market data used to determine the cost-of-debt allowance: typically, regulators rely on long-term data (typically a 10-year time horizon) to estimate the cost of debt. This is mostly to:
  - mitigate the impact of short-term financial fluctuations, such as those in interest rates, especially given the recent volatility experienced in financial markets;
  - to align with the time horizon of investments in network assets, which typically extend over the long term.

3.4. Alternatives to WACC

In the context of the revenue cap methodology, if the allowed cost of capital is determined as the weighted average of i) allowed cost of equity, and ii) allowed cost of debt, regulated undertakings have an incentive to:

- minimise the cost of procuring capital, especially if a notional gearing is used for regulatory purposes; and/or
- move towards the capital structure that is deemed efficient by the regulator, in order to minimize the risk of any adverse impact on the regulated undertaking of unexpected movements in the cost of equity or debt capital.

Some regulators do not use the WACC, in the sense that they do not fix the overall allowed cost of capital (equity + debt) as a weighted average of the costs of the two components. Instead, they separately allow a rate of return on equity and a

[39] See UK Regulators Network (UKRN) (2023), page 32.

rate of return on debt. For example, in some cases the German energy regulator treats in a different manner:

- equity-financed assets, which are remunerated by employing a cost of capital determined as the sum of a nominal risk-free rate and a risk premium (market risk premium multiplied by a *beta* risk factor plus an additional risk compensation – a variant of the CAPM); and
- debt-financed assets, for which a pass-through of actual financing costs is envisaged[40].

However, if this methodology is employed, actual debt costs should be considered as part of the regulator's wider cost efficiency assessment (e.g. the cost of debt should be subject to incentive mechanisms similar to those typically applied to operating costs). Otherwise, regulated undertakings would not have any incentive to minimise the cost of debt.

Furthermore, the regulator would have no means to incentivise undertakings to move toward a capital structure deemed efficient.

3.5. Consistency of alternatives with the prospected Ei methodology

All methodologies (and variants) considered above regarding the setting of:

- the allowed cost of equity (CAPM, ATP, Three-Factor model, ICAPM, CCAPM, DDM, DGM, Risk Premium and Build-up methods);
- the allowed cost of debt; and
- the allowed overall cost of capital (WACC vs pass-through of the costs of debt);

are consistent with a revenue cap methodology that provides for RAV setting at historical costs.

In fact, all methodologies (and variants) allow to determine a cost of capital expressed either in nominal or in real terms:

- should the RAV be expressed in nominal terms (historical costs), the allowed (nominal) cost of capital will have to be determined by employing the nominal rates of returns based on indices and parameters observed on the financial markets;
- should the RAV be expressed in real terms (revalued historical costs), the allowed (real) cost of capital will have to be determined deducting inflation from the nominal rates of returns based on indices and parameters observed on the financial markets (typically employing the Fisher equation[41]).

Furthermore, the allowed rate of return on capital should reflect the (efficient[42]) cost of capital required to carry out the regulated business during the regulatory

[40] Sources: i) CEER (2024), ii) CEPA (2023) and iii) BNetzA, "Beschluss für die vierte Regulierungsperiode für Elektrizitätsnetzbetreiber (BK4-21-055)', October 2021.

[41] See Fisher (1930).

[42] The cost of capital that is deemed efficient by the regulator.

period under consideration[43]. This holds true regardless of whether a forward-looking approach (e.g. the current replacement costs methodologies employed by Ei) or backward-looking approach (RAV setting through historical costs) is employed. This implies that in both cases the allowed cost of capital should reflect the best estimation of the expected (efficient) cost of capital that will be incurred by regulated undertakings[44].

[43] In fact, typically regulators set *ex-ante* the allowed return on capital for the whole regulatory period.

[44] Please note that best estimation of the expected cost of capital could be based on both forward-looking and historical market data, depending on data availability.

4. CONSIDERATIONS ON THE WAY FORWARD

The methodology currently used for setting network tariffs in Sweden suffers from a number of inconsistencies, mostly related to the use of different indices or benchmarks to determine and update the RAV and the remuneration to be applied to that RAV.

The electricity and gas transmission and distribution segments include undertakings with different ownership structures and of different sizes. As discussed in Section 3.1. , neither of these aspects should be relevant in setting the regulatory remuneration for the electricity transmission and distribution activities

In setting the remuneration of the capital employed by regulated undertakings, the following aspects should be addressed:

- How to recognise, in the regulatory context, the different sources of funding (equity and debt) and their relative importance in financing the regulated activities;
- How to determine the RAV;
- How to determine the allowed cost of debt;
- How to determine the allowed cost of equity;
- How to deal with inflation in setting the remuneration of the invested capital.

4.1. How to recognise the capital structure of the regulated undertakings

There are two main ways to recognise that regulated undertakings are financed by at least equity and debt:

- include the actual cost of debt among the allowed costs and set the allowed remuneration only for the equity capital;
- leave the actual cost of debt out of the allowed costs and provide an allowed remuneration for both equity and debt financing.

The use of the second option allows regulators also to promote the optimal capital structure and funding of regulated undertakings. In this case, the regulatory WACC is nothing else than a way of recognising the two main sources of financing of regulated activities. Moreover, as already commented in Section 1, within an incentive-regulation framework, the incentivising properties of this framework do not depend on the notional capital structure used in determining the regulatory WACC, and therefore such a structure does not need to reflect the actual one of the regulated undertaking(s).

However, to the extent that, under such a framework, regulated undertakings have an incentive to choose the capital structure which minimises their financing cost, one could expect that, after a few regulatory periods, the actual financial structure of the regulated undertakings is somehow optimal and therefore could provide a

useful reference in calculating the WACC[45]. However, as highlighted in Section 3, the municipal network companies in Sweden enjoy more favorable financing terms, not generally available across the sector, which may affect the choice of the optimal financing strategy. Therefore, while the general consideration about the irrelevance of the financial structure used in determining the WACC on the incentivising properties of the approach holds in Sweden as in all other jurisdictions, it would seem unjustified to use the actual financial structure of these undertaking(s) in determining the WACC to be applied to the whole sector. Therefore, if historic debt/equity ratios were to be used as benchmarks, the sample would have to be limited to those undertakings operating according to fully commercial conditions.

In any case, reference could be made to the data recently published by Council of European Energy Regulators (CEER) (CEER, 2024), indicating that most of its member regulators use a debt/equity ratio of 60/40.

4.2. How to determine the Regulatory Asset Value

In Sweden, the RAV for:

- electricity network activities is determined:
  - at the beginning of a regulatory period, by using a UPL, comprising the current/latest acquisition or construction costs of a large number of asset components;
  - during the regulatory period, by updating the RAV using a construction cost index, reflecting neither the costs of the energy network transmission and distribution assets, nor the general inflation level;
- gas network activities is determined at historical costs and revalued on a yearly basis employing a sector specific inflation index.

Both these approaches can be interpreted as variants of the 'replacement value' methodology for determining the RAV, which has been shown to:

- expose electricity transmission and distribution undertakings to unnecessary risks;
- not necessarily ensure the funding necessary to replace existing assets at the end of their economic lives (also because of technological development)[46].

Therefore, in our opinion, backward-looking methodologies (based on historical costs) are better suited to provide a proper remuneration of the capital invested in energy network activities, thus reducing the risk for investors investing in the sector and therefore allowing it to attract the capital needed to finance new investments.

We will consider how inflation can be taken into account in the context of a backward-looking methodology in Section 4.5. below.

[45] This approach could hold for the past and present. Going forward, if regulated undertakings knew that their choice of gearing affects the future notional capital structure used to set the WACC for regulatory purposes, they might choose a capital structure which is not only optimal at present, but also when seen with respect to its impact on the WACC which the regulator will set in the future.

[46] See paragraph 3.1.1 for further details.

4.3. How to determine the allowed cost of debt

The cost of debt shall reflect the typical rating of undertakings providing the electricity transmission and distribution services.

The Swedish Regulator uses a BBB rating as reference, which seems well to reflect the average rating of the commercial undertakings providing transmission and distribution services in Sweden.

However, municipal undertakings have the possibility of borrowing from Interbank, a cooperative bank with an AAA rating and therefore able to borrow on the international financial markets at more favourable rates. Nonetheless, this opportunity in not available to all undertakings operating in the transmission and distribution business and, therefore, should not affect the approach to the determination of the cost of debt in setting the regulatory remuneration. In fact, such more favourable borrowing terms relate to the public-ownership characteristic of the municipal undertakings. If more favourable borrowing terms mean a cost of debt lower than the one embedded in the allowed remuneration of the RAV, and based on a BBB credit rating, the benefits of such lower costs should accrue to the public owners of these undertakings, for providing the guarantees which determine the higher, AAA, rating.

4.4. How to determine the allowed cost of equity

There are different methodological approaches to the determination of the returns on the equity that the market expects for investments in regulated activities and which, therefore, the regulator should allow to attract the required risk capital.

We have presented and assessed these alternative approaches in Section 3.2. above. The CAPM is the most widely used and avoids the complexities and/or circularity of other approaches.

Under the CAPM, the cost of equity of an energy transmission or distribution undertaking depends on:

- The risk-free rate;
- The degree of systematic risk involved in energy transmission or distribution activities (measured through the '*beta*' parameter);
- The market premium.

The CAPM can be used to determine the expected rate of the return of an activity or of its equities in the undertaking's capital.

The Swedish regulator is currently using the CAPM and determines the '*beta*' on the basis of a sample of comparable companies operating in electricity and gas transmission and distribution sectors.

This approach conforms to best regulatory practice, and it is used by the great majority of the European regulators.

Furthermore, all alternatives to the CAPM do not allow to overcome the main critical implementation issue of the CAPM, namely the difficulty in identifying the correct comparables. Setting the criteria to identify comparable companies is a very sensitive matter in the context of regulatory practice. Some discretion must

be exercised, thus making regulator's decisions debatable from the regulated undertakings' point of view. However, regulators could rely on international best practices in order to identify the right criteria: CEER collects and provides information regarding the 'value of the asset and equity '*betas*' used by its members, most of the energy regulators in Europe[47].

4.5. How to deal with inflation in setting the remuneration of the invested capital

The regulatory allowed remuneration of the invested capital can be determined in nominal-value or real-value terms. They differ in the way in which the RAV, the rate of return and the annual depreciation allowances are expressed/calculated:

- In the nominal-value approach:
  - the RAV is determined as the sum of the acquisition/construction costs of the assets in the RAB (RAV expressed at historical costs);
  - the rate of return on the RAV is expressed in nominal terms;
  - the annual depreciation allowance is determined, each year, as a proportion (depending on the depreciation method chosen) of the RAV expressed at historical costs.
- In the real-value approach:
  - the RAV is revalued every year using an appropriate indexation;
  - the rate of return on the RAV is expressed in real terms (i.e. net of inflation);
  - the annual depreciation allowance is determined, every year, as a proportion (depending of the depreciation method chosen) of the revalued RAV.

Both approaches provide the same net present value (NPV) of the allowed remuneration as long as, in the real-value approach, the same (inflation) rate is used for indexing the RAV and for netting inflation out of the rate of return.

However, the nominal-value approach provides an earlier remuneration of the capital invested in the regulated activities.

The majority of European regulators use the nominal-value approach, as shown in Table 2 below, which:

- avoids the need to index the RAV and to net inflation out of the rates of return (as they are observed in nominal terms in the financial markets);
- provides earlier returns to regulated undertakings which typically have a value of time higher than society (i.e. consumers).

Therefore, in our opinion, the nominal-value approach is preferable in setting the allowed rate of return on capital in energy network regulation.

However, the transition from the current approach needs to be carefully managed, considering that, depending on what transition approach is used, the RAV might

[47] See CEER (2024).

experience a step change (Finland has just been through a similar transition, with safeguards for the regulated undertakings).

In determining the best transition approach, the regulator should consider the trade-off between ensuring some level of continuity in the allowed revenues of the regulated undertakings, on the one side, and ensuring that they can be properly remunerated for the capital invested in the business and/or that consumers do not overpay for the service, on the other hand. This aspect however involves not only the cost of capital, but also how the RAV is valued and therefore goes beyond the scope of this Report.

Table 2 *RAB valuation methods and allowed remuneration of invested capital in energy networks in a selection of European countries*[48].

Country	Rate of return	RAB valuation
Austria	Nominal	Historical costs
Belgium	Nominal	Historical costs
Croatia	Nominal	Historical costs
Cyprus	Nominal	Historical costs
Czech Republic	Nominal	Historical costs
Denmark	Nominal	Historical costs
Estonia	Nominal	Historical costs
Finland	Nominal	Historical costs
France	Nominal	Historical costs
Germany	Nominal	Historical costs
Greece	Nominal	Historical costs
Hungary	Real	Revalued historical costs
Ireland	Real	Revalued historical costs
Italy	Real	Revalued historical costs
Lithuania	Nominal	Historical costs
Luxembourg	Nominal	Historical costs
Netherlands	Real [49]	Revalued historical costs
Northern Ireland	Real	Revalued historical costs
Norway	Nominal	Historical costs
Poland	Nominal	Historical costs
Portugal	Nominal	Historical costs
Romania	Real	Revalued historical costs
Slovakia	Nominal	Historical costs
Slovenia	Nominal	Historical costs
Spain	Nominal	Historical costs
Sweden	**Real**	**Replacement costs**
UK	Real	Revalued historical costs

As shown in Table 2, most EU regulators rely on a nominal-value approach, applying a nominal rate of return to a RAB valued at historical costs. Other

[48] Source: CEER (2024) and national regulators' decisions. Please note that, in some countries, different approaches are employed to gas and electricity network or for TSOs and DSOs. In Table 2 we refer to the most widely used methodology. In some countries, the use of book values is allowed as a proxy of historical costs.

[49] For electricity transmission and distribution activities, a "real-plus" WACC is employed from 2022. The real-plus WACC is derived by removing half of the consumer price index inflation (CPI) from the nominal WACC.

regulators employ a real-value approach combining a real rate of return with the revaluation of historical costs, where revaluation is implemented mainly employing a consumer price inflation index.[50]

The RAV is revalued using half of the estimated inflation. In other words, 50% of inflation is compensated through the WACC, and 50% through the RAV revaluation.

[50] In Italy, the RAB is yearly revalued employing an inflation index those measures price changes of investment goods (the so called “deflatore degli investimenti fissi lordi”). However, ARERA, the Italian regulator, is considering moving towards a consumer price inflation index (see consultation document 340/2024/R/com).

ANNEX A CRITERIA FOR THE IDENTIFICATION OF COMPARABLE COMPANIES

Typically, in setting the criteria for the identification of comparables, regulators aim at selecting companies that:

- carry out the same (or similar) activity as the undertakings to be regulated;
- are subject to a similar regulatory framework as the one applied to the undertakings to be regulated (and, therefore, are subject to a similar level of risk).

However, different approaches may be followed in achieving these general objectives. In this Annex we describe the approaches adopted by Ofgem and ARERA - respectively the British and Italian energy regulators - to select comparables in setting the allowed cost of equity.

THE OFGEM APPROACH

The British energy network sector is characterised by large operators both at transmission and distribution levels (6 electricity DSOs and 6 gas DSOs). A Totex methodology, known as RIIO (Revenue = Incentives + Innovation + Outputs), is used to determine the allowed revenues of regulated undertakings. To determine the allowed cost of capital, Ofgem uses the WACC methodology combined with the CAPM to determine the cost of equity.

RIIO-2[51] and RIIO-3[52] decisions on the allowed cost of capital relied on a 2018 study commissioned by Ofgem to Cambridge Economic Policy Associates Ltd (CEPA) (CEPA, 2018).

Regarding the selection of comparables, to set the benchmark *beta* parameter, CEPA states:

- "*The inclusion of observed comparable companies to benchmark the appropriate equity beta requires careful consideration. Ideally, comparator companies should be pure-play – publicly traded company focused on only one industry or product – though these comparators are difficult to find. In practice, regulated utility network comparators may have international or non-regulated business areas which distort the equity beta. Benchmarking against companies that are not pure plays may require discretionary adjustments to the equity beta, upward or downward.*";
- "*A larger sample size of comparator companies may be more statistically significant, however a smaller, more representative sample size may better reflect the systematic risk of the company in question. Betas can be estimated*

[51] Ofgem, "RIIO-2 Final Determinations – Finance Annex (REVISED)", 2021

[52] Ofgem, "RIIO-3 Sector Specific Methodology Decision – Finance Annex", 2024

by averaging the betas of every company within a particular industry (such as a Bloomberg Classification), or through hand-selecting a few specific companies that are particularly relevant in terms of future business risk."

Given these high-level criteria of selection - combined with consideration of availability and reliability (in terms of adequate liquidity of underlying securities) of available market data – Ofgem selected, for RIIO-3, the comparables listed in the following table.

Table 3 *Comparables proposed by Ofgem to determine the electricity transmission, gas transmission and gas distribution networks sector specific betas*[53]

Company	**Description**
United Utilities	UK water network company
Severn Trent	UK water network company
National Grid	UK electricity and gas TSO/DSO
Enagas	Spanish gas TSO
Red Electrica	Spanish electricity TSO
Terna	Italian electricity TSO
Snam	Italian gas TSO

The inclusion in the sample of both British water companies and (national and international) energy network companies was justified by Ofgem as follow: "*On balance, we provisionally see a net benefit in including European utility companies in our comparator set. While these companies operate in a different country and under a different regulatory regime, they are likely to face similar challenges relating to meeting net zero targets. We see this compromise as thematically similar to the compromise involved in using GB Water comparators. In Water we have a different sector but a very similar regulatory regime. With European energy network comparators we will have the same sector but a potentially different regulatory regime.*"[54]

[53] Ofgem employs the same comparables for both gas and electricity networks, because "*we* [Ofgem] *do not think that there is sufficient data to isolate evidence that there is a structural premium in gas, or justify a set asset beta premium for gas over electricity*". Ofgem, "RIIO-3 Sector Specific Methodology Decision – Finance Annex", 2024, Par 3.200

[54] Ofgem, "RIIO-3 Sector Specific Methodology Decision – Finance Annex", 2024, Par 3.197.

THE ARERA APPROACH

The Italian and Swedish electricity and gas distribution sectors are similar in the following aspects:

- Highly-fragmented markets: 119 electricity DSOs (80 with less than 5.000 network users) and 186 gas DSOs (47 with less than 5.000 network users)
- State and municipalities hold majority shares in most of the DSOs
- Only large DSOs are publicly-listed companies (or controlled by publicly-listed companies)[55]

For each sector (gas and electricity), the allowed cost of capital is the same for all DSOs, regardless of the size and the ownership structure of the regulated undertakings. To determine the allowed cost of capital, ARERA (the Italian NRA) uses a WACC methodology combined with the CAPM to determine the cost of equity.

Comparable companies used as a benchmark to set the *beta* parameter have to:

- be listed in the financial markets;
- operate in activities similar to the activities carried out by the regulated firms: at least 20% of the turnover coming from regulated activities;
- be subject to similar regulatory regimes (firms should therefore be active in the European and UK markets);
- be sufficiently liquid in the financial markets, based on indicators such as the bid–ask spread as a percentage of closing prices and the share turnover[56].

The following tables list the comparables recently proposed by ARERA[57] to determine the sector specific beta parameters.

Table 4 *Comparables proposed by Arera to determine the electricity transmission's sector specific beta*

Company	Description
Elia Group	Belgian electricity TSO
National Grid	UK Electricity and gas TSO/DSO
Red Electrica de Espana	Spanish electricity TSO
Ren Redes Energeticas Nacionais	Portuguese electricity and gas TSO/DSO
Terna	Italian electricity TSO

[55] ARERA. (2023), *Relazione Annuale, Stato dei servizi.*

[56] A measure of stock liquidity calculated by dividing the total value of shares traded over a period of time by the average market capitalisation of the stock for the period. The higher the share turnover, the more liquid a stock. For example, a high trading volume would indicate that a stock can be bought and sold easily.

[57] ARERA, Consultation document 342/2024/R/com regarding the update of the allowed WACC for the sub-period 2025-2027.

Table 5 *Comparables proposed by Arera to determine the electricity distribution's sector specific beta*

Company	**Description**
A2A	Italian multi-utility
Acea	Italian multi-utility
Électricité de Strasbourg	French multi-utility
Hera	Italian multi-utility
Iren	Italian multi-utilitiy
National Grid	UK Electricity and gas TSO/DSO

Table 6 *Comparables proposed by Arera to determine the gas transmission's sector specific beta*

Enagas	**Spanish gas TSO**
Fluxys Belgium	Belgian gas TSO
National Grid	UK electricity and gas TSO/DSO
Ren Redes Energeticas Nacionais	Portuguese electricity and gas TSO/DSO
Snam	Italian gas TSO
TRANSGAz	Romanian gas TSO

Table 7 *Comparables proposed by Arera to determine the gas distribution's sector specific beta*

Enagas	Spanish gas TSO
A2A	Italian multi-utility
Acea	Italian multi-utility
Ascopiave	Italian gas DSO
Hera	Italian multi-utility
Iren	Italian multi-utilitiy
Italgas	Italian gas DSO
National Grid	UK electricity and gas TSO/DSO

ANNEX B ACADEMIC LITERATURE ON THE RELATIONSHIP BETWEEN ALLOWED RETURNS AND OWNERSHIP STRUCTURE

There is a substantive academic literature looking at the relationship between allowed returns of regulated undertakings and their ownership structure. While this Annex does not pretend to be exhaustive in reviewing this literature – it would be beyond the scope of this Report –, we present below the conclusion reached by a number of relevant studies.

In general, evidence suggests that privately-owned companies might be able to obtain higher allowed revenues, but, as indicated in the text, this seems more the result of the interaction between the regulator and the regulated undertakings, rather than a justified and deliberate strategy by the regulators:

- Renzetti and Dupont (2003) reviewed several studies looking at the relationship between ownership and performance of water utilities in France, the UK and the US. They found no compelling evidence of private utilities outperforming public utilities. The same conclusion is observed in the literature review of Walter et al. (2009);
- Florio and Florio (2013) looked at IEA and OECD data on electricity companies for EU15 Member States over thirty years and found that public ownership is associated with lower residential electricity prices in Western Europe, but that the impact of liberalisation on prices is small and uncertain;
- García Valiñas et al. (2013) assessed the relationship between provider ownership and the price of water for residential use set by 386 Southern Spanish municipalities. Their analysis was more detailed that those of other scholars, as they went further than merely distinguishing between private and public ownership. They found that (i) water prices are lower when the urban water service is directly provided by town councils, (ii) if water services are contracted out to external companies, the prices set by public utilities are higher than the prices set by private utilities, and (iii) water prices are also higher when the provision of the service has been privatised to an institutionalised public-private partnership compared to contractual public-private partnerships;
- Wait and Petrie (2017) analysed the relation between water utility ownership structure and the price of water, while controlling for other factors such as water source, population size, population density, population growth trends, service area size, and drought condition. The study used price data for water utilities in 485 cities in the US (333 publicly owned, 152 privately owned), representing a range of city sizes and geographic distribution. The study concluded that, on average, privately owned water utilities are able to charge higher prices for water;

- Porcher (2017) analysed an original dataset of 115 water utilities in 2009 serving more than 9 million consumers in France and found that there are no appreciable differences between the prices charged by directly-managed public utilities and those whose management is contracted out;
- Rufino and Nóbrega Cavalcante (2024) analysed a sample of public utility-sector companies - water and sanitation, piped natural gas and electricity - regulated by administered prices over the period 2007 to 2019. They concluded that the private identity of the owner of the capital leads to regulatory decisions that are more aligned with the interests of maximising the profitability of the regulated companies. They considered this result to be consistent with the perspective of the economic rationality of private investors to maximise returns and the perspective that public investors prioritise other outcomes rather than abnormal returns.

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