NERA
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Economic Assessment of the Swedish Energy Markets Inspectorate's Beta-Determination for Electricity Network Operators 2020-2023

Report for E.ON Energidistribution AB

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1. Introduction

1.1. Scope of Work

E.ON Energidistribution AB ("E.ON") has commissioned NERA Economic Consulting GmbH ("NERA", "we") to provide an assessment of the regulatory cost of capital decision by the Swedish Energy Markets Inspectorate ("Ei") for electricity networks applicable for the regulatory period from 2020 to 2023. As directed by the Swedish regulation of electricity networks, the regulatory cost of capital is determined using the Weighted Average Cost of Capital method and the Capital Asset Pricing Model for the cost of equity, which, in turn, makes use of a business-specific so-called "beta-coefficient" to assess the risk of electricity network operators relative to general market risk. E.ON has asked us to focus our review on the estimated beta coefficient in particular.

Ei's decision closely follows regulation issued by the Swedish government in 2018. For our assessment, we analyse the specific instructions contained in the applicable regulation and Ei's interpretation of these instructions. In our analysis of the regulatory cost of capital and beta coefficient below, we discuss the merits of the Swedish regulation, our interpretation given economic best-practices, and assess Ei's chosen approach. Finally, we determine a recommended beta for Swedish electricity network operators, given the instructions contained in the regulation.

1.2. Background

In August 2018, the government has issued Ordinance 2018:1520[1] ("the ordinance") entailing provisions for determining the revenue cap for electricity network operators in accordance with the Electricity Law of 1997.[2] These provisions contain detailed instructions regarding the regulatory cost of capital. Paragraphs 17-25 specify rules for to calculate the regulatory cost of capital using a Weighted Average Cost of Capital ("WACC"). The cost of equity, which is part of the WACC, is determined according to the Capital Asset Pricing Model ("CAPM"). The CAPM models the cost of equity as the sum of a risk-free rate and a risk premium. The risk premium equals the product of a general market risk premium and the beta-coefficient, which measures the degree to which network operators are exposed to general market risk.[3]

[1] Förordning (2018:1520) om intäktsram för elnätsverksamhet; accessible at: https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-20181520-om-intaktsram-for_sfs-2018-1520

[2] Ellag (1997:857); accessible at: https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/ellag-1997857_sfs-1997-857

[3] Previous Swedish WACC-determinations also included an additional risk premium for network operators, to account for specific risks not contained in the general market.

Due to the lack of listed Swedish electricity network operators, paragraph 18 of the ordinance further specifies that the WACC should be based on comparator companies satisfying defined criteria.[4] The ordinance gives detailed instructions for calculating each of the parameters of the CAPM in the subsequent paragraphs. For this report, the most relevant provision concerns the calculation of the asset beta in paragraph 25.

The regulatory period 2020 – 2023 is the first regulatory period for which the ordinance is applicable. To assist its 2019 decision, Ei commissioned a report by the consulting company Montell & Partners to propose parameter values for the appropriate level of gearing (net debt ratio), the credit risk premium and the beta-coefficient.[5] For most of the parameters, Montell & Partners present a range of values, which result from various methodological modifications. In Appendix 7[6] of its decision, Ei explains its decisions for the calculation of the parameter values for the 2020 – 2023 regulation period. Ei is careful to use only those parameters, which, according to the Ei's assessment, were derived in accordance with the ordinance.

Table 1.1
Swedish WACC-Parameters and Decision

	Parameter	Formula	Values *(%, except beta)*
A	Net Debt Ratio		49.00
B	Tax Rate		20.80
C	Asset Beta		0.29
D	Equity Beta	=C*(1+(1-B)*A/(1-A))	0.51
E	Risk-Free Rate (nominal)		0.90
F	Equity Risk Premium		6.68
G	Cost of Equity (nominal, post-tax)	=E + D * F	4.31
H	Cost of Equity (nominal, pre-tax)	=G/(1-B)	5.44
I	Debt Premium		1.44
J	Cost of Debt (nominal, pre-tax)	=E+I	2.34
K	**WACC (nominal, pre-tax)**	**=A*J+(1-A)*H**	**3.92**
L	Inflation Rate		1.73
M	**WACC (real, pre-tax)**	**=(1+K)/(1+L)-1**	**2.16**

Source: Ei

[4] Comparator companies must: 1) have electricity transmission as their main business, 2) be listed on a European stock exchange, and 3) have its headquarter in Europe.

[5] Montell & Partners (2019) Parametrar till bedömning av kalkylränta för elnät 2020-2023.

[6] Energimarknadsinspektionen (2019) Bilaga 7: Kalkylränta för elnätsföretag, För tillsynsperioden 2020 – 2023.

Table 1.1 shows Ei's decision on the regulatory cost of capital. Ei determines the different parameters as follows:

- Ei relies on five comparator companies: Elia System Operator (Belgium), Red Electrica (Spain), Terna (Italy), Redes Energeticas Nacionais (Portugal), and National Grid (UK). A sixth company, Romanian Transelectrica, is excluded from the initial sample of companies due to an unusual net debt to equity ratio.
- The net debt ratio (gearing) is derived by calculating the average value of comparators during the 2009 – 2018 observation period and is set to 49%.
- Montell & Partners recommend an asset beta of 0.37, using data from the five comparators, weekly observations, a European reference index, and the effective tax rate for each year and company. Montell & Partners remove data points with low explanatory power through R^2-filtering. However, Ei rejects the proposed approach to calculate the asset beta. Instead, Ei relies on a specification using a global reference index, the 2018 corporate tax rates, and no filtering of the calculated betas to determine an asset beta of 0.29.
- Ei sets the risk-free interest to 0.90% and an equity risk premium of 6.68%, following the method prescribed in the ordinance.
- To account for a planned change in the Swedish corporate tax rate in 2021, Ei uses the average tax rate for the regulatory period of 20.8%.
- Ei determines the cost of debt by adding the debt premium of 1.44% proposed by Montell & Partners to the risk-free interest rate. The debt premium was calculated as the spread between German government bonds and corporate bonds issued by European energy companies with a BBB rating, each with 10 years of maturity.

The parameter values result in a nominal, pre-tax WACC of 3.92% for the 2020 – 2023 period. Ei assumes an expected inflation rate of 1.73%. Consequently, the real pre-tax WACC amounts to 2.16%

The Swedish WACC-decision for electricity network operators is among the lowest of all European WACC-allowances.[7] At 0.29, the Swedish beta determination is the lowest asset beta determination in Europe; approximately 26% below the European average of 0.39.

Although significant choices regarding data selection and methodology are fixed in the ordinance, the Ei is left with a certain margin for appreciation when determining the asset beta (as

[7] We analyzed the most recent decisions (dating from 2016 to ongoing consultations) for the following countries: Austria, Belgium (including its separate decisions for Brussels, Flanders and Wallonia), Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Switzerland, and the United Kingdom.

opposed to other parameters in the WACC formula which are governed in even more detail in the ordinance). As instructed by E.ON, this report therefore focuses on the determination of the beta-coefficient for Swedish electricity network operators.

1.3. Structure of the Report

Our report discusses the Swedish Ordinance 2018:1520 and its application, to determine the appropriate value of the beta-coefficient for Swedish electricity network operators. It is structured in the following way:

- Section 2 provides a general discussion of problems associated with setting detailed legal instructions in the context of network regulation.
- Section 3 discusses the specific prescriptions of the ordinance with reference to current best-practice and contains an interpretation to derive our preferred approach for determining asset beta in accordance with the instructions of the ordinance. The section discusses how and why our approach differs from Ei's methodology.
- Section 4 comments on the particular choices made by Ei and their effect on the asset beta. The section compares Ei's determination to precedent cases from other European regulators and the estimates of financial analysts.
- Section 5 quantifies the beta following our preferred approach (given the prescriptions of the ordinance) and contains sensitivity analyzes as well as comparisons to relevant benchmarks.
- Section 6 summarizes the results and concludes.

2. General Considerations

The regulatory cost of capital aims to compensate investors adequately, i.e. in line with capital market expectations, for the risks associated with investments in network infrastructure. This ensures the right balance between low network charges and necessary investment in the electricity grid. The "true" cost of equity – and hence the "true" cost of capital – is not directly observable from market data. Estimating and subsequently setting the rate of return therefore involves economic models, assumptions and other methodological choices. Since available methods and the quality (or representativeness) of data are not constant over time, there is no perpetual "gold standard" for estimating the cost of capital, as reflected in the variety of models applied and assumptions relied upon by academics, regulators and practitioners. This does not, however, imply that every chosen method will lead to "correct" estimates. The unavoidable task for each academic, practitioner or regulator is to assess the available methods and data, and decide which combination of models, methods, data and assumptions best fits expected capital market conditions.

The following chapters outline why it is undesirable to severely restrict the methodological discretion of regulatory authorities. Chapter 2.1 discusses risks relating to fixing specific models and estimation approaches to determine the regulatory cost of capital. Chapter 2.2 considers the asymmetric risks associated with setting the regulatory cost of capital.

2.1. Risks of Fixing Regulatory Methodology

Ordinance 2018:1520 contains detailed instructions for calculating the cost of capital of Swedish network operators, with the aim of reducing uncertainty and promoting regulatory stability. It *de facto* prescribes the use of the Weighted Average Cost of Capital (WACC) and the use of the Capital Asset Pricing Model (CAPM). The ordinance thereby limits the ability of Ei to respond to changes in circumstances and economic methods. Detailed instructions for determining the cost of capital rule out or delay the adoption of economic methods that are either 1) newly available or 2) newly suitable because of changed financial market conditions or regulatory changes. This restricts Ei's ability to approach the "true" cost of capital. In addition, the detailed instructions may not achieve the Swedish government's goal of regulatory stability.

For example, the ordinance includes detailed instructions for the calculation of each parameter of the WACC and CAPM; however, the use of the CAPM is not uncontroversial. Nobel laureate Fama and French, for example, conclude regarding the suitability of the CAPM: *"Unfortunately, the empirical record of the model is poor – poor enough to invalidate the way it is used*

in applications."[8] Fernandez similarly criticises the use of the CAPM in the regulatory context.[9] Multifactor models and dividend growth models could both be used as alternatives. Asset pricing models are a major strand of research in economics and finance. For these reasons, ruling out the use of alternative models (to the CAPM) entails the risk of using the "wrong" model, if a better model becomes available or an already existing model becomes more suitable.[10]

As regards the beta estimation, new models have recently been introduced into the regulatory context. The British regulator Ofgem thoroughly considers using GARCH models instead of the conventional ordinary least squares techniques. The Kahlman-filters are another novel approach to estimating beta. Regulators like Ofgem, which are not bound by detailed instructions, are frontrunners when it comes to adopting new methods out of academia into the regulatory context.[11]

These examples highlight a fundamental problem with a fixed method for setting the cost of capital: detailed instructions for determining the cost of capital effectively rule out the application of such novel models.[12] Ei may be forced to adhere to an outdated methodology to determine the regulatory cost of capital in future. The resulting regulatory cost of capital is unlikely to be the best possible estimate of the network operators "true" cost of capital.

We understand that the Swedish government passed the ordinance to simplify the process of setting the cost of capital and avoid legal disputes; however, experiences in Germany suggest that it may result in the opposite. The German government gives detailed instructions to the regulator for calculating the allowed cost of capital. When setting the cost of equity for the current regulatory period, the German regulator aimed to simply update the method employed for previous regulatory period to preserve regulatory stability.[13] During the consultation phase, the German regulator categorically rejected methodological alternatives. German network operators subsequently challenged the regulatory decision in court, arguing that extraordinary

[8] Fama and French (2004): The Capital Asset Pricing Model: Theory and Evidence, Journal of Ecoomic Perspective, Volume 18, Number 3, p. 25–46.

[9] Fernandez (2019): WACC and CAPM according to Utilities Regulators: Confusions, Errors and Inconsistencies.

[10] The latter could occur, if e.g. a Swedish network operator launched an initial public equity offering. In this case, using a dividend growth model may be superior to the CAPM based on comparators.

[11] Ofgem often serves other regulators as role model and many of the regulatory instruments to developed by Ofgem in have been adopted by other international regulators. Ofgem developed the so-called TOTEX -approach (TOTEX: TOTal EXpenditures), which aims at disincentivising strategic overinvestment in fixed assets and hence intends to cure existing problems within the regulatory framework. The use of TOTEX has been considered in various jurisdictions, including Sweden.

[12] For example, the 10-year period to estimate the beta coefficient, which the Swedish ordinance prescribes, would not have a straightforward interpretation, if the GARCH model was applied. (See for example: Stock and Watson (2007): Introduction to Econometrics, Pearson International Edition, Second Edition.)

[13] Bundesnetzagentur (2016): Decisions BK4-16-160 and BK4-16-161, 5 October 2016.

circumstances on financial markets require an alternative methodological approach. The economic expert hired by the appeal court found the German regulator's approach to be schematic. He pointed out that the results were at odds with capital market conditions citing various alternative models as evidence. On that basis, the court repealed the regulatory decisions stating that the regulator cannot simply apply a single fixed formula, even if it has worked in the past.[14] The Federal Supreme Court re-installed the regulator's initial decision after a further appeal, because it found that two biases in the regulator's decision offset each other.[15]

The example from Germany highlights two further problems associated with a fixed method for setting the cost of capital. First, the resulting determinations have a higher risk of being at odds with capital market conditions, meaning that the cost of capital is set too high or too low. A substantial diversion from conventional cost of capital estimations provides an argument for an appeal in court. Second, regulatory determinations which follow detailed instructions prevent effective consultation of network operators and hence increases the probability for overlooking or ignoring legitimate concerns by stakeholders. The methodological discussions, which should take place during the consultation phase, are subsequently moved into the courtroom.[16]

In addition to the risk that the regulatory cost of capital will not correspond to the market's estimations, and the risk of lengthy court proceedings, detailed instructions to calculate the cost of capital can ultimately increase the cost for consumers. In light of the issuance of ordinance 2018:1520 and the corresponding WACC decision, the rating agency S&P Global states with respect to the Swedish regulatory regime:[17]

"Additionally, our current strong assessment of the Swedish regulatory framework reflects our view of the framework as predictable and stable, with an independent regulator and tariff-setting process. In our opinion, politicians' recent involvement in setting the level of remuneration by issuing decrees could result in our re-assessment of the Swedish regulatory framework. (...) We could also lower the rating by more than one notch if we re-assess the Swedish regulatory framework as less than strong."

[14] Oberlandesgericht Düsseldorf (2018): Decision VI-3 Kart 319/16 [V], 22 March 2018.

[15] In particular, the Federal Supreme Court pointed out that the regulator had overestimated the risk-free rate and underestimated the equity risk premium. See decisions EnVR 41/18 and EnVR 52/18, both dated 9. July 2019.

[16] In addition to the appeal by the network operators, the EU Commission is challenging the legality of Germany's transposition of the Electricity Directive and the Gas Directive, arguing that it unduly restricts the independence of the national regulator. (See EU Commission: Infringement – Internal energy market: Commission refers Germany and Hungary to the Court of Justice of the EU for failure to fully comply with the Third Energy Package, Press release on 19 July 2018, accessible at: https://ec.europa.eu/commission/presscorner/detail/en/IP_18_4487

[17] S&P Global Ratings (2019): "Outlook On Ellevio's Senior Secured And Subordinated Debt Revised To Negative; 'BBB' And 'BB+' Ratings Affirmed", 5 July 2019.

A downgrading would increase the cost of capital of Swedish network operators. To accommodate this increase, the Swedish regulator must either increase the allowed cost of capital or run the risk of the network operators not recovering their cost of capital. This example highlights another problem with such a detailed regulatory framework, as both options increase the cost for consumers in the long run.

In summary, legally fixing a detailed methodology to determine the cost of capital, as done by Ordinance 2018:1520, is unlikely to increase regulatory stability and avoid legal disputes. Instead, it may force the regulator to use outdated or inadequate methodologies, prevent open consultations with stakeholders and fix the regulatory cost of capital at a level that deviates from market expectations according to economic theory. As discussed in more detail below, the Swedish regulation does contain such fixed, detailed instructions which are not aligned with current economic theory, which confirms and enhances this problem. Furthermore, strong political interference in the regulatory framework causes uncertainty and weakens regulatory stability. Ultimately, this increases the costs for network operators and network users.

2.2. Asymmetric Risks in Fixing Regulatory Cost of Capital

Preserving regulatory discretion regarding the cost of capital is important to address asymmetric risk. As discussed previously, the "true" cost of capital is not observable and hence associated with uncertainty. The regulatory decisions may therefore either be too high or too low relative to the "true" cost of capital. Asymmetric risk means that that the consequences of setting the regulatory cost of capital either too high or too low are different.

In the case of electricity network regulation, setting the cost of capital too high will increase costs for network users. This cost increase is shared among millions of individual customers and will hence lead to limited price increase for individual network users. Because electricity demand does not change significantly when prices increase slightly,[18] setting the cost of capital too high does not have far-reaching consequences for the real economy.

In contrast, setting the cost of capital too low makes infrastructure investments unattractive and can hence lead to underinvestment. Underinvestment can adversely impact security of supply and impede the restructuring of the energy supply chain which will be necessary to meet decarbonisation targets. The consequences for the real economy of setting the cost of capital too low can thus be substantial.

Regulatory authorities acknowledge the risk asymmetry and frequently set WACCs nearer the upper end of determined ranges. For example, the UK Competition Commission notes the

[18] Put in economic terms, the electricity demand is said to be "inelastic".

asymmetric risks of errors in WACC determinations and their consequences on investment.[19] The Commission expresses the view that the welfare costs of marginally too high prices are lower than the welfare cost of marginally too low prices. Several regulatory agencies share the view that risks of underinvestment outweigh the risks of marginally too high returns on regulated capital. Examples include:

- Luxembourg: *"The risks of estimation are mitigated by adopting a cautious approach oriented towards the upper end of the recommended range"*[20]
- Great Britain: *"The CAA is also mindful of the consequences for airport users over time of under- or over-estimating the cost of capital might be asymmetric, with the detrimental long-term impact of under-investment (resulting from a rate of return that is too low) potentially outweighing the short-term impact on prices through a rate of return that is too high."*[21]
- New Zealand: *"The NZ commission notes concerns about the asymmetric nature of errors in assessing the WACC, i.e., underestimation is the more serious error because it may lead to underinvestment by the regulated companies."*[22]

A review of regulatory precedence by the British Civil Aviation Authority concluded, that point-estimates for WACCs were mostly drawn from the upper half of their range. Consequently, the CAA chose an estimate towards the upper end of its identified range of WACCs.[23] The Austrian regulator similarly adheres to its "cautionary principle" and chose a WACC towards the upper end of the range in its second regulatory period for gas network operators, with the following reasoning:

"For E-Control, it is an essential principle to ensure the long-term existence of the networks and the associated high quality of network services – based on the above-mentioned principle

[19] UK Competition Commission (4. November 2008): „Stansted Price Control Review", Final Report, Appendix L paragraph 115/116; accessible at: https://webarchive.nationalarchives.gov.uk/20140402204820/http://www.competition-commission.org.uk/our-work/directory-of-all-inquiries/stansted-price-control-review/final-report-and-appendices-glossary (accessed 10. February 2020)

[20] Institut Luxembourgeois de Regulation "Résultat de la consultation publique se terminant le 28 janvier 2016 portant sur les taux de rémunération des capitaux investis dans les réseaux de transport, de distribution et industriels, applicables pendant la période de régulation 2017 à 2020 – Secteur Electricité", 19.04.2016. Original quote: *"Les risques d'estimation sont mitigés en adoptant une approche prudente orientée vers la zone haute de la fourchette recommandée"*

[21] CAA (December 2006): „Airports Price Control Review – Initial Proposals for Heathrow Gatwick and Stansted", paragraph 18.7.

[22] New Zealand Commerce Commission (November 2004): „Gas Control Inquiry report", paragraph 9.92

[23] CAA (2013): „Economic regulation at Heathrow from April 2014: initial proposals", paragraph 9.132.

of prudence, the WACC is therefore deliberately approximated to the upper range of the values proposed by the expert"[24]

The review of regulatory precedent cases shows that regulators are aware of asymmetric risks and tend to set the cost of capital towards the upper end of ranges derived by experts. Such ranges will not exist, if the methods for determining the cost of capital are specified in legal detail. Regulators bound by detailed methodological instructions are not able to accurately account for the uncertainty regarding the "true" cost of capital and the risk associated with setting the cost of capital too low. The asymmetric risk is especially problematic when the capital market conditions deviate from their historic averages (which increases the uncertainty about the "true" cost of capital), and when significant network expansion and restructuring is necessary. Both is currently the case for European financial markets and Swedish electricity network operators, respectively.

[24] E-Control (2012): „Regulierungssystematik für die zweite Regulierungsperiode Gas", S.29. Original quote: *"Für E-Control ist es ein wesentlicher Grundsatz den langfristigen Bestand der Netze und die damit verbundene hohe Qualität der Netzdienstleistungen sicherzustellen – aus dem oben genannten Vorsichtsprinzip wird daher der WACC bewusst an die obere Bandbreite der vom Gutachter vorgeschlagenen Werte angenähert"*

3. Determination of Asset Beta

Despite the many detailed provisions in ordinance 2018:1850, which limit methodological choice and the range of outcomes, it is not possible to simply follow the ordinance to the letter and arrive at one undisputable figure for the cost of capital. Consequently, the determination based on the ordinance is also influenced by necessary assumptions and decisions of the regulator. Such decisions involve trade-offs between different objectives and require careful analysis with reference to economic best-practice.

The regulator's discretion to make certain assumptions and methodological decisions is especially relevant in the determination of the beta-coefficient. The beta is a key parameter of the CAPM and measures the risk of Swedish electricity network operators relative to alternative investment opportunities. Empirically, the beta-coefficient is estimated by regressing the stock return of individual network operators against the returns of the broader market, to assess the relative riskiness of network operations.

The Swedish ordinance details the approach for beta determination in paragraph 18 (criteria selecting reference companies) and paragraph 25 (instructions for determining asset beta). According to paragraph 25, the asset beta shall be determined relative to i) a global reference market, ii) using weekly stock returns, iii) using ten years of historic data and iv) using current tax rates. The ordinance prescribes several important methodological decisions; however, it does not specify each necessary step for the empirical beta estimation and thus it leaves discretion regarding its application. The differing empirical specifications – which are possible in accordance with the ordinance – yield a range of potential beta-coefficients.

In the following chapter we assess the methodology to determine the beta-coefficient as prescribed by the ordinance and as applied by Ei or its consultant Montell & Partners. We discuss the most important methodological choices: the selection of comparators (chapter 3.1), the data period (Chapter 3.2), the choice of reference index (Chapter 3.3), the return definition (Chapter 3.4), beta adjustment and filtering of observations (Chapter 3.5), and tax rates used for unlevering equity betas (Chapter 3.6). Each chapter is structured in three sub-chapters:

1) ***Methodological considerations****:* This sub-chapter discusses a specific necessary choice for beta estimation by considering economic theory, best-practice and European precedent, and outlines how an "ideal" estimation approach differs from the prescriptions by the Swedish ordinance.

2) ***Application of the ordinance****:* This sub-chapter outlines our interpretation of the ordinance and derives our recommended approach to estimate the Swedish asset beta for electricity network operators given the restrictions imposed by the ordinance.

3) ***Comparison with Ei****:* This sub-chapter identifies and discusses differences between our approach and Ei's chosen approach to estimate the beta coefficient.

The approach derived to estimate the beta-coefficient (which is applied in Chapter 5 as our "preferred" approach) is subject to choices imposed by the ordinance and therefore not an approach we would apply absent the detailed prescriptions of the ordinance.

3.1. Comparator Sample

Most Swedish electricity network operators are not publicly listed on stock exchanges and are therefore unavailable for further analysis. The Swedish network operator listed on the stock exchange, E.ON, has substantial additional business activities with different risk profiles. Hence, E.ON is not necessarily representative of a pure-play Swedish network operator. The absence of listed Swedish pure network operators requires the reliance on "comparators", comparable foreign companies with similar risk profiles listed on the stock exchange.

3.1.1. Methodological considerations

The selection of comparators is crucial to deriving the appropriate beta coefficient and involves a trade-off between sample size and comparability in terms of the business risks between the sampled companies and Swedish electricity network operators. Two concerns are most relevant:

- **Sample size:** Any empirical estimation, even with a "perfect" sample of comparators, is potentially subject to random variation in data and a resulting bias. A large sample of comparators is generally preferable, to balance individual company or country effects and reduce the influence of random variation in data. The use of few comparators increases the sensitivity to outliers in the sample and increases the risk of setting an inappropriate cost of capital.

- **Comparability:** Selected companies must reflect the risk profiles of Swedish electricity network operators. Due to the widespread existence of integrated utilities, i.e. companies owning the networks but also generation assets or trading businesses, and private ownership of network operators, there are very few "pure" network operators, which limits the number of potential comparators.

Regulators face a trade-off between sample size and comparability. They have to balance the requirement of similar business activities with the benefits of large samples of comparators. Prescribing narrow conditions regarding the selection of comparators restricts the ability of the regulator to choose the optimal sample of comparators.

There are three dimensions along which regulators tend to differ:

1) The **sector** from which comparators are considered,

2) the **geographic** reach of potential comparators, and

3) The "**purity**" of network operators, i.e. the share of network activities relative to total business activities by the company.

The Swedish ordinance restricts potential comparators to European electricity network operators. Other European regulators have developed similar criteria to select suitable companies. To reduce the risks of bias, regulators increase the sample of comparators by considering similarly regulated gas network operators or by including comparable non-European network operators. Table 3.1 summarises the approaches of European regulators for selecting comparators.

Table 3.1
Comparators for Beta Estimation

Country	Year	Region	Sector	Comparators
Austria	2018	Global	Electricity & Gas	14
Belgium (DSO)	2016 / 2019*	Global / Europe*	Electricity & Gas	9 / 10*
Finland (DSO)	2019	Europe	Electricity	9
France	2016	Europe & Commonwealth	Electricity & Gas	17
Germany	2016	Global	Electricity & Gas	14
Luxembourg	2016	Global	Electricity & Gas	9
Netherlands	2016	Europe	Electricity & Gas	8
Norway	2019	Global	Electricity & Gas	16
Spain	2019	Western Europe	Electricity & Gas	29
Switzerland	2019	Europe	Electricity	10
Sweden	2019	Europe	Electricity	5

** Flanders / Wallonia*

Source: Nera analysis. Table excludes the UK, Belgium (national) and Portugal, which use their respective listed network operators to estimate the cost of capital. The comparators relied upon in Italy are not publicly available.

As shown in Table 3.1, several regulators (including Sweden) consider European network operators only, while others select non-European comparators as well. Two considerations are relevant in this respect: 1) does the risk profile of non-European network operators differ from those in Europe? And 2) does limiting the sample to European companies reduce the comparison to European networks? Since network operators are regulated as natural monopolies in all industrialised countries, their respective risk profiles are unlikely to differ substantially. Regulatory frameworks in Australia and New Zealand are particularly similar to those common in Europe. Furthermore, using only European companies does not limit the comparison to

European networks. Many European network operators, e.g. National Grid or Redes Energeticas Nacionais, have substantial overseas operations in North or South America. The formal restriction to European companies does not have the desired effect of comparing only European electricity networks. Considering non-European countries increases the number of potential comparators and hence reduces the influence of firm or country specific effects on the estimate. A larger sample with a broader geographic reach is therefore preferable. Yet, the Swedish ordinance explicitly prohibits relying on non-European comparators.

In addition to electricity network operators, many regulators include gas network operators as appropriate comparators and assume comparable risk profiles in both sectors. For example, the German Federal Network Agency argues in its reasoning of the last regulatory cost of capital decision that: [25]

"*The qualitative risk analyses reviewed whether differences between operators of electricity- and gas networks exist. The ruling chamber concludes that under the current regulatory framework, it found no arguments against the combined inclusion of electricity network operators and gas network operators in the comparison group"*

By restricting the comparison group to electricity network operators, the Swedish ordinance excludes potentially comparable companies prior to any in-depth analysis.

The third criteria to assess comparability – the share of network activities – is more difficult to assess. The assessment requires two methodological decisions to select comparators: the acceptable share of electricity network activities relative to other business activities, and the metric used to determine the share. Using a relatively high threshold for network activities relative to other business activities reduces the number of comparators. Setting the threshold too low, however, dilutes the risk profiles of the selected companies. In practice, regulators have to specify somewhat arbitrary thresholds, below which companies are deemed unsuitable.

Considering the number of chosen comparators in Table 3.1 reveals differences. The number of companies selected ranges from eight in the Netherlands to 29 in Spain (compared to only five in Sweden). Accordingly, the adopted thresholds for determining comparability range substantially:

[25] Bundesnetzagentur (2016): Decisions BK4-16-160 and BK4-16-161, 5 October 2016, p. 18. Original quote: "In der qualitativen Risikoanalyse wurde im Schwerpunkt überprüft, ob Unterschiede zwischen Betreibern von Elektrizitäts- und Gasversorgungsnetzen bestehen. Im Ergebnis hat die Beschlusskammer unter den bestehenden Rahmenbedingungen keine Argumente gefunden, die gegen eine gemeinsame Einbeziehung von Elektrizitätsnetzbetreibern und Gasnetzbetreibern in die Vergleichsgruppe sprechen."

- **Netherlands**: the Dutch regulator places a high value on a similar risk profile to its native network operators and excludes even National Grid, a frequently chosen comparator.[26]
- **Germany**: the national regulator specifies that 75% of business activity must be generated by network activities.[27]
- **France**: the threshold for inclusion in the comparator group is a 70% share of network activities. Integrated utilities are considered separately.[28]
- **Switzerland**: comparators must mainly operate in the European market with electricity transmission or -distribution constituting the main or a substantial part of business activities. In practice, the lowest share of network activities of the selected comparators was 36%.[29]
- **Finland**: due to the separate determination of asset betas for transmission and distribution networks, the Finnish regulator relies on integrated utilities as comparators for DSOs. For some (e.g. RWE AG), regulated network operations accounted for less than 20% of business activities at the time of determination.[30]
- **Spain**: the exact share of network activities necessary for energy companies to be included as comparators is not specified in the decision. Given the largest sample of companies of any surveyed regulator (29) despite the narrow geographic eligibility (Western Europe) and the inclusion of several integrated utilities (e.g. RWE AG, EDF S.A. and EDP S.A.), the effective threshold is relatively low.[31]

In general, countries restricting their set of eligible comparators to European companies or electricity network operators tend to set lower thresholds for network operations relative to (unregulated) business activities. Regulators with high thresholds consider gas network operators, and frequently non-European companies.[32] There are notable exceptions to this analysis. The Dutch regulator with the lowest number of comparators has similar geographic and sectoral restrictions as the Spanish regulator with the largest number of comparators. The two regulators

[26] ACM (2019): Gewijzigd methodebesluiten GTS 2017-2021, kenmerk ACM/UIT/505475, zaaknr ACM/18/033721, Bijlage - Uitwerking van de methode voor de WACC.

[27] Bundesnetzagentur (2016): BK4-16-160

[28] Frontier Economics (2015): Èvaluation du taux de remuneration des gestionnaires de résaux d'électricité et de gaz naturel en France.

[29] IFBC (2012): Risikogerechte Entschädigung für Netzbetreiber im schweizerischen Elektrizitätsmarkt.

[30] EY (2014): Eneiavirasto Kohtuullisen tuottoasteen määrittäminen sähkö- ja maakaasuverkkotoimintaan sitoutuneelle pääomalle.

[31] Comisión Nacional de los Mercados y la Competencia (2019): Memoria Explicativa de la Circular de la Comisión de los Mercados y la Competencia, por la que se establese la metodologia de cálculo de la tasa de retribución financiera de las actividades de transporte y distributición de energía eléctrica, y regasificación, transporte y distribución de gas natural, Cir/DE/01119.

[32] These observations reflect the trade-off which regulators face when determining a comparator sample.

with similar geographic and sectoral restrictions to Sweden, Finland and Switzerland, accept low thresholds for the share of network-related activities.

In addition to setting a threshold, regulators must choose a metric to assess whether the threshold has been met. There a two broad metrics to assess the chosen threshold: turnover or profit. In practice, it is not always possible to rely completely on one metric or the other. For example, the consultant of the German regulator evaluates companies principally on turnover, however, complements this analysis considering EBITDA. The Swiss regulator on the other hand relies on EBITDA and uses turnover or gross profits, where data is unavailable.

In the CAPM, the beta measures the risk of a company relative to the general market. The beta is estimated by comparing the stock returns of a company to stock returns of the general market. Stock returns are directly linked to current and expected profits.[33] An increase in expected profits increases the stock return and a decrease in expected profits decreases the stock return. The beta therefore measures the degree to which expected profits of a given company depend on the expected average market profits. Such direct relationship does not exist between turnover and stock returns and hence also not between turnover and the beta.

In the case of network operators, focussing solely on turnover as a metric to assess comparability can distort the assessment. Different business activities differ in their profit relative to turnover. Trading companies generally generate large turnover relative to profits – and hence low profit margins – whereas capital intensive companies typically generate higher profit margins and lower turnover.[34] Utilities often combine network operations with sales. While electricity sales and trading activities generate large turnover with low margins, the opposite is true for network operations. Only considering turnover shares for such companies underestimates the significance of network operations in their business mix. The beta measures the sensitivity of profits to market fluctuations. Profits are therefore a more appropriate metric than turnover to assess the relative importance of network operations and their effect on beta.

Estimating betas based on comparators involves trade-offs between the sample size of comparators and the comparability to Swedish network operators. The sample of comparators should be as large as possible, to reduce potential distortions from outliers. We therefore consider it best-practice to include gas network operators as well as non-European companies in the pool of potential comparators. To assess the comparability of network operators, the share of operating profit generated with network business is the superior metric.

[33] To illustrate this point, consider an equity analyst valuing the stock of a given company. This equity analyst will discount expected profits of the company to assess whether the current market price of the stock is below or above the fair value. If market participants believe in the analyst's finding, the stock price will adjust, thereby generating a negative or positive return.

[34] For a more detailed theoretical discussion, see e.g. „DuPont System", in Richard Brealey and Sewart Myers (2000) Principles of Corporate Finance. Sixth Edition. McGraw-Hill Higher Education, p. 834-836

3.1.2. Application of the ordinance

The Swedish ordinance prescribes three criteria for choosing appropriate comparators in paragraph 18: Companies must 1) have electricity network operation as main business area, 2) be listed on a European stock exchange and 3) have their headquarters in Europe.

Criteria 2) and 3) are unambiguous. As discussed above, they restrict the potential number of comparators, which is not our preferred approach and does not actually limit the comparison to European networks.

The meaning of "main business", however, is not further defined and there are several plausible interpretations. Criteria 1 could restrict comparisons to companies almost exclusively in the business of network operation. Alternatively, companies with a majority of its business in network operations, or even companies where network operations are merely the largest business segment could be considered.

Given the restriction to European electricity network operators placed by the ordinance, sampling many comparators is difficult. To avoid relying on a very narrow sample of companies, we would not set the threshold as high as in France or Germany. Considering only regulators with similar criteria suggests a threshold of around one-third of all activities for its network operations. Companies with potentially more than half of its activities in unregulated sectors, however, dilute the risk profile of the chosen sample. We therefore view the share of 50% network activities to meet the "main business" criteria as an acceptable compromise.

As discussed above, we prefer operating profit as metric to assess comparability. Several European regulators use turnover shares to assess the comparability of candidate companies. The European companies fulfilling the 50% turnover or operating profit criteria are:

- National Grid Plc (United Kingdom)
- Terna S.p.A. (Italy)
- Redes Energeticas Nacionais S.A. (Portugal)
- Red Eléctrica Corporación S.A. (Spain)
- Elia System Operator S.A. (Belgium)
- Transelectrica S.A. (Romania).
- Iberdrola S.A. (Spain)
- Endesa S.A. (Spain)
- E.ON S.E. (Germany)

Except for Terna, Elia and Transelectrica, all of the above companies complement their electricity network business with other businesses. Endesa's share of electricity network operations in operating profit is substantially larger than their share of electricity network operations in turnover. This finding is consistent with Endesa's sales business (see discussion above). E.ON operates some of the Swedish networks and recently restructured its business to increase the share of regulated network activities. As a result, the network share of operating profits exceeds 50% in 2015 for the first time. E.ON can therefore be considered a network operator for at most four out of the ten year review period. For this reason, we exclude E.ON as comparator for the current regulation period. All other companies fulfil the criteria on average for the ten-year period from 2009 to 2018.

Our preferred sample for estimating the beta thus consists of the following eight companies: National Grid, Terna, Redes Energeticas Nacionais, Red Eléctrica Corporación, Elia System Operator, Transelectrica, Iberdrola, and Endesa. The sample includes both transmission and distribution network operators.

Comparing the comparators with selections in other countries confirms the sample. National Grid, Terna, Redes Energeticas Nacionais, Red Electrica and Elia are used by almost all European regulators. Iberdrola and Endesa are chosen in Spain, Switzerland, Norway and Finland.[35] Transelectrica is used in Switzerland since 2013. Other frequently used companies, e.g. Snam or Enagas, are not eligible, because they mainly operate gas networks. Other electricity network operators, e.g. EDF S.A. (France), RWE A.G. (Germany), EDP S.A. (Portugal) or EVN A.G. (Austria) generate less than 50% of their operating profit with their electricity network business and therefore do not meet our threshold.

With eight comparators, the estimation relies on a relatively small sample due to the limitations put in place by the ordinance. Only the Dutch regulator relies on eight comparators for its estimation, however, the ACM uses an exceptionally high threshold and includes gas network operators as comparators. The two other regulators relying on the same geographic and sectoral restrictions as prescribed by the Swedish ordinance (Switzerland and Finland, see Table 3.1) rely on ten and nine comparators respectively, and include several utilities with lower network operation shares.[36] A larger and more suitable group of comparators could be identified without the restrictions of the ordinance. Due to the small size of the sample, it is important to consider the influence of individual outliers on the result. In Chapter 3.5 we discuss how to adjust raw estimates and how to filter results.

[35] The Finish regulator uses Enel, Endesa's main shareholder (>70%) in its comparator sample for electricity distribution networks.

[36] The table only lists the comparators for Finish DSO beta determination. Including the comparators used for TSOs increases the total number to 13 comparators.

3.1.3. Comparison with Ei

Montell & Partners and Ei apply a threshold of at least 50% turnover from electricity network operations for comparators. They rely on National Grid, Terna, REN, Red Electrica and Elia as comparator companies to determine the beta. This is the smallest sample size of all surveyed regulatory authorities (see Table 3.1).

Montell & Partners initially identify Transelectrica as suitable comparator. Transelectrica is subsequently excluded from the sample due to its low share of debt during the assessment of gearing. Excluding Transelectrica when assessing the appropriate level of gearing, i.e. the net debt ratio, is a justifiable filtering of outliers. When estimating beta-coefficients, however, the different financing structures of companies are explicitly corrected for when unlevering betas using the Hamada-Formula (for more detail see Chapter 3.6). We therefore disagree with the assessment of Montell & Partners and Ei and recommend including Transelectrica as comparator.

The sample selected by Montell & Partners only includes transmission network operators, even though the beta determination is mainly applied to distribution network operators. This is the result of the strict interpretation of the "main business" criteria. There is no complete consensus on whether the two sectors have identical risk profiles. Many regulators determine business risks jointly, but some differentiate between them (e.g. France, Finland, Italy, Portugal and Belgium). In all separate determinations except in France, DSOs receive higher betas than TSOs. [37]

As a result of the narrow range of eligible companies and a strict interpretation of the 'main business' criteria by Montell & Partners, Ei relies on the smallest sample of comparators of any European country for its determination of the regulatory cost of capital. Because of the small number of companies and the lack of DSOs among comparators, the potential impact of errors and outliers in the regression-based estimation is greater. To reduce the influence of outliers and potential bias, we prefer to rely on a larger sample of comparators.

3.2. Data Period

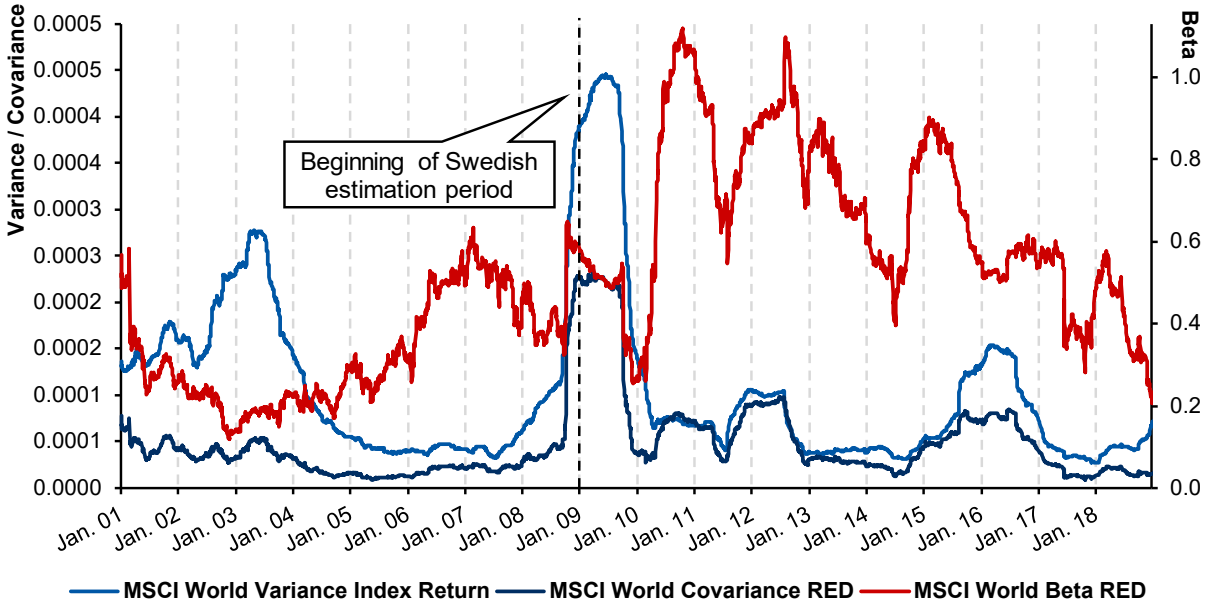
Beta estimates vary over time. Changes in financial markets and structural breaks in data series can introduce biases when forecasting betas on historical data. Choosing an appropriate time period is therefore an important element when determining the beta.

[37] The higher beta for RTE (French TSO) compared to Enedis (French DSO) is not the result of the regulatory authority, the CRE, finding higher business risk in the transmission business. It results from the CRE's finding that RTE has higher operating leverage meaning that RTE has a higher share of fixed costs relative to variable costs than Enedis.

3.2.1. Methodological considerations

The prescription of a fixed time period to estimate the beta rests on the assumption that past data is representative for the future. Structural breaks and other significant changes in financial markets violate this assumption. Past performance is not necessarily the best predictor of the future. The prescription of a fixed time period restricts the flexibility of the regulator to evaluate complex market conditions.

Figure 3.1
One-year Rolling Variance, Covariance and Beta of RED



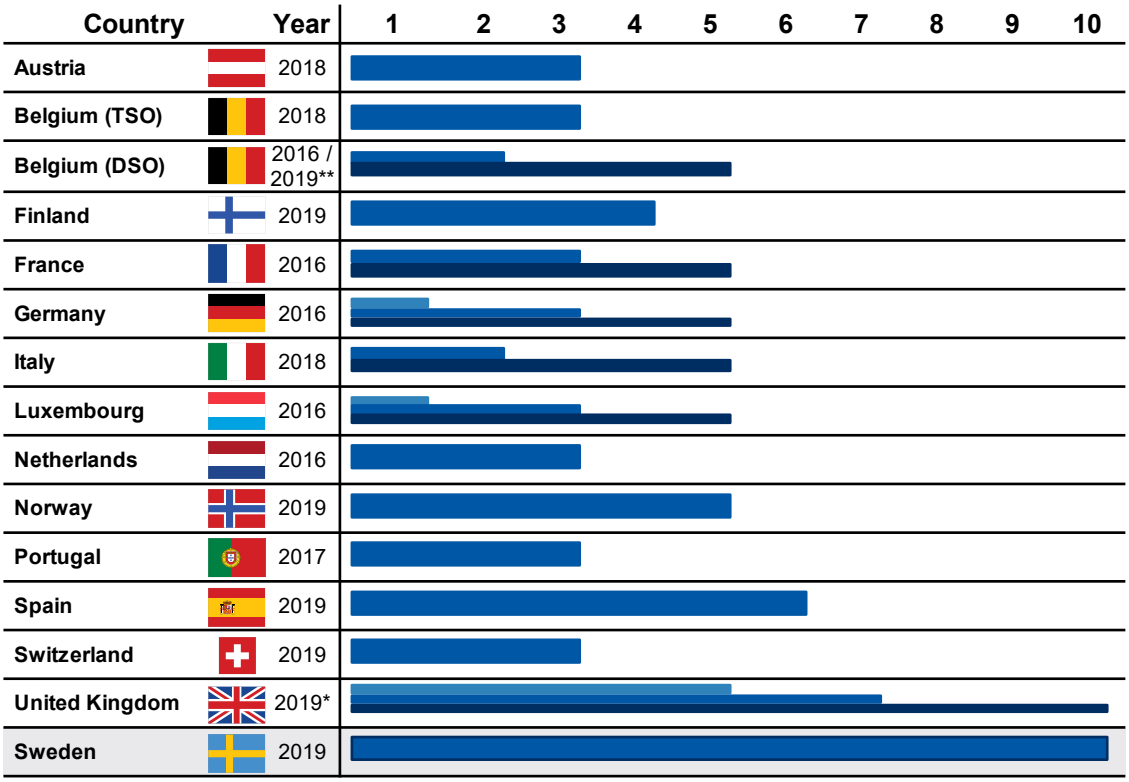
Source: NERA analysis

The need for flexibility by the regulator is highlighted by a closer analysis of Red Electrica (RED), the Spanish transmission network operator. Figure 3.1 shows the rolling one-year estimates of the variance of the daily returns (light blue line) of the MSCI World Index (the reference index used by Ei), the covariance between daily returns of the MSCI World and the stock of RED (dark blue line), and the raw equity beta obtained by dividing the covariance by the variance (red line, right axis). The variance and covariance increased sharply in 2009 during the Eurozone crisis and raw equity betas increased above 1.1 in 2010. In the explanatory note to the regulatory decision, the Spanish regulating authority explicitly discusses the importance of the time period when estimating parameter values of the WACC and opts for a six-year period to capture some, but not all crisis induced risk.[38]

[38] Comisión Nacional de los Mercados y la Competencia (2019): Memoria Explicativa de la Circular de la Comisión de los Mercados y la Competencia, por la que se establese la metodologia de cálculo de la tasa de retribución financiera de las actividades de transporte y distributición de energía eléctrica, y regasificación, transporte y distribución de gas natural, Cir/DE/01119, pp. 32-35

The Swedish ordinance fixes the period for estimating net debt, equity and the beta of the comparator companies to ten years. Instead of such a mechanistic approach, a regulator should carefully consider which time periods are representative for the future. In RED's case, this may not be the case for the estimated betas during the peak of the crisis, and neither with regards to the recent decline.

Table 3.2
Time Period for Beta Estimation



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*** Flanders (light blue) / Wallonia (dark blue)*
Source: NERA analysis

Table 3.2 shows the time periods used by other European regulators, which tend to be substantially shorter than in Sweden. Most countries use (less than) five years of data or weight recent years higher. Most regulators use three- or five-year periods, or a combination of several time periods. E.g. Luxembourg and Germany weight relatively recent data higher than older observations. In light of the shorter time periods considered by other regulators, it could be reasonable to weight recent years more heavily when determining the beta-coefficient. The British regulator Ofgem is the only other regulator using ten years of data for its estimation, in addition to shorter time periods.

The suitable reference period for estimating the beta is subject to change. Depending on the circumstances, a ten-year period may be optimal to identify long-term averages for stable

parameters. The exact period used, however, should be subject to a careful assessment by the regulator, rather than fixed as part of the regulation.

3.2.2. Application of the ordinance

The Swedish ordinance stipulates that the asset betas shall be determined using stock market data of the past ten calendar years preceding the decision, i.e. the "data period" is the ten years from 2009 to 2018. The ordinance does not, however, specify a time period for each regression (e.g. each year separately versus one ten-year regression) or how each observation should be weighted in the aggregated estimation (equal weighting or prior selection).

As discussed, structural breaks in the data can bias the estimation. Relying on longer time periods for beta estimation increases the probability of including structural breaks in the data series. Ten years is an unusually long period for estimating beta coefficients. The ten-year period from 2009 to 2018 includes the aftermath of the financial crisis, the euro zone sovereign debt crisis and the extended period of near zero nominal interest rates induced by quantitative easing. For example, Figure 3.2 shows how the variance of the MSCI World returns (the denominator for beta estimates), almost quintupled in 2009 compared to just two years earlier and sharply fell again in 2010 and 2011. This reflects the extraordinary turbulences on global financial markets following the financial crisis.

Episodes of extreme market conditions merit a closer examination of results and may be justifiably excluded from final analyses. Filtering data, i.e. selectively excluding observations based on additional information and economic knowledge, can increase the robustness of the estimation by removing unrepresentative observations.

The potential need of adjusted weighting and filtering of results points towards calculating individual regressions for each year as a starting point for further analysis. The alternative of calculating one ten-year regression for each company makes identifying potential outliers and filtering results more difficult.

3.2.3. Comparison with Ei

Ei and Montell & Partners follow the same approach and calculate ten separate yearly regressions. They then average these regressions of all years and companies. For Montell & Partners the yearly regressions serve a purpose as a starting point for filtering. Considering that no actual filtering was performed by Ei, it would have been more efficient, i.e. given a more precise estimate from a purely statistical point of view, to calculate ten-year regressions for each company instead.

3.3. Reference Index

The beta measures the degree to which the returns of a given company follow general market fluctuations. The "reference index" is the market index used to approximate the general market.

3.3.1. Methodological considerations

In principle, rational investors diversify their investments across different asset classes, different sectors and different countries. Network operators compete with other investment opportunities for the capital to build and maintain the network infrastructure. Although these "other investment opportunities" include alternative asset classes such as real estate, usually broad stock indices are used as reference markets. The Swedish ordinance prescribes the use of a global stock index for estimating the beta, to reflect the global investment opportunities.

Table 3.3
Reference Index for Beta Calculation

Country	Year	National	European	Global
Austria	2018	✓		
Belgium (TSO)	2018	✓		
Belgium (DSO)	2016 / 2019**	✓	/** ✓	
Finland	2019	✓		
France	2016	✓		
Germany	2016	✓		
Italy	2018	✓	✓	
Luxembourg	2016	✓		
Netherlands	2016		✓	
Norway	2019	✓		
Portugal	2017	✓		
Spain	2019	✓		
United Kingdom	2019*	✓		
Sweden	2019			✓

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*** Flanders / Wallonia*
Source: NERA analysis

Compared to regulatory precedent, the use of a global stock index is unusual. Table 3.3 shows that Sweden's Ei is alone among European regulators in its insistence on a global reference market. Almost all other regulators use national indices as benchmarks, often choosing the relevant FTSE All-World national indices to ensure comparability. To our knowledge, the only other regulator considering a global index as part of the analysis is Norway. The analysis of

the consultant hired by the Norwegian regulator includes several different specifications including a global index; however, the consultant ultimately rejects the use of a global index and bases the recommendation for the beta on national reference indices. Despite similar objectives, other regulators prefer European or national stock indices as reference markets.

There are three economic reasons why European regulators decide against using a global reference index: 1) Equity portfolios exhibit a so-called "home-bias" and national stock markets already comprise substantial international diversification, 2) Lower correlation with a global index does not imply lower relative risk of European stocks, and 3) Potential distortions due to the timing of index calculation for an index spanning almost all time-zones. Appendix A includes a discussion of each of these reasons. Together, these reasons suggest that relying on a global reference market introduces a potential bias into the beta determination which outweighs the assumed conceptual benefits of using a global reference market.

In light of the issues with choosing a global stock index and considering best-practice among European regulators – all of which similarly understand the need to choose an appropriate reference index to assess the business risks of network operators – our preferred approach is to rely on national or a European reference index. Montell & Partners also recommend using a European reference index to Ei.

3.3.2. Application of the ordinance

Paragraph 25 of the ordinance prescribes the use of a "global" reference index. As discussed, using a global reference index is highly unusual and not our preferred approach. No other regulator relies on a global reference index.

Without prejudice to our reasoning above, we understand global to refer to an international stock index such as the S&P Global 1200. The S&P Global includes 1200 companies from North America, Europe, Asia, Australia and Latin America.

3.3.3. Comparison with Ei

Ei uses the MSCI World as reference index, despite Montell & Partners' recommendation of using a European reference index, which would be a superior choice (see Appendix A). Ei's use of global reference index is an example of economic arguments being discarded due to the unusual prescriptions of the ordinance.

The MSCI World includes approximately 1600 companies from 23 industrialized countries (mostly the USA and Europe). It therefore has a smaller geographic diversification than the S&P Global or the related MSCI All-Country Index. Nonetheless, these indices tend to be highly correlated. The choice of a specific global index therefore appears to be an issue of minor importance.

3.4. Return Definition

When determining the beta, it is necessary to specify a time interval over which stock returns are calculated. Regulators and other practitioners use daily, weekly or monthly stock returns to estimate betas. The appropriate return definition mainly depends on data availability. Generally, short time intervals increase the sample size and are desirable from a statistical point of view.

3.4.1. Methodological considerations

A guiding principle in empirical analyses is to include the greatest amount of the available data in the analysis. Increasing the number of observations increases the precision of the estimation and reduces the influence of outliers. Using daily stock returns maximises the number of observations and appears appropriate to estimate betas.[39]

Table 3.4
Data Frequency for Beta Estimation

Country	Year	Daily	Weekly	Monthly
Austria	2018	✓		
Belgium (TSO)	2018	✓		
Belgium (DSO)	2016 / 2019**	✓		
Finland	2019		✓	
France	2016	✓		
Germany	2016	✓		
Italy	2018	✓		
Luxembourg	2016	✓		
Netherlands	2016	✓		
Norway	2019			✓
Portugal	2017	✓		
Spain	2019		✓	
Switzerland	2019			✓
United Kingdom	2019*	✓		
Sweden	2019		✓	

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*** Flanders / Wallonia*
Source: NERA analysis

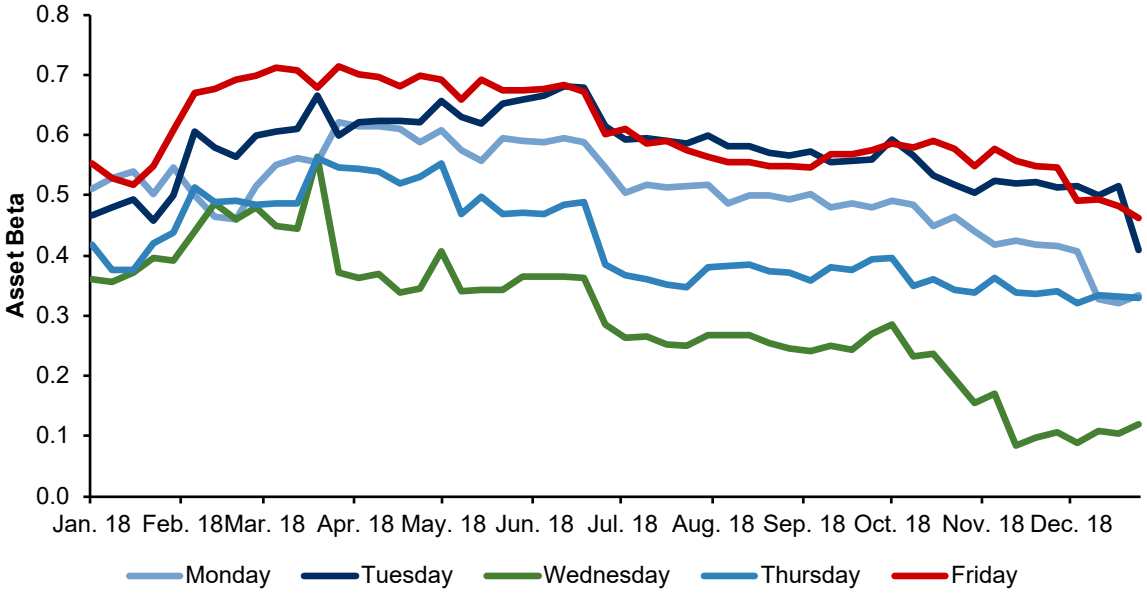
Table 3.4 shows that most European regulators choose daily data to determine betas. The use of weekly or monthly returns is uncommon. Yet, the Swedish ordinance prescribes weekly data.

[39] Using weekly data may be necessary or superior, if daily data is not available or if a stock is not traded in a liquid market.

3.4.2. Application of the ordinance

The ordinance prescribes the use of weekly returns as basis for the beta calculation. Given the use of a global reference index, this reduces (though does not eliminate) the bias from time zone differences compared to daily data. The ordinance does not specify; however, how weekly returns should be calculated. The ordinance leaves discretion regarding the choice of weekdays.

Figure 3.2
Rolling weekly one-year Equity Betas by Weekday



Source: Nera analysis based on the comparator group relied upon by Ei.

Figure 3.2 illustrates that the choice of weekdays influences the resulting beta-estimates. The diagram shows that equity betas differ by as much as 0.5. With Ei's comparator group, Friday-Friday betas generally produced the highest betas in 2018, while Wednesday-Wednesday betas were the lowest. Over the ten-year period (2009-2018) and the comparator sample selected in Chapter 3.1.2, Monday returns produce the highest returns and Wednesday returns the lowest.

Relying on only one out of five possible weekly return definition (e.g. Friday-Friday) discards useful information. To fully exploit the information contained in the data, we prefer to calculate weekly returns for each day of the week and to average the resulting betas.

3.4.3. Comparison with Ei

Ei and Montell & Partners use Friday-Friday returns to estimate betas. Friday-Friday returns tend to be near the average of the other weekdays over the ten-year period. The impact of this methodological decision on the result is relatively small. Nonetheless, using Friday-Friday betas discards useful information and introduces a potential source of bias. We therefore disagree with the approach chosen by Ei.

3.5. Beta Adjustments and Filtering

The beta is estimated by regressing the stock returns of the comparator companies on the returns of a stock market index. This statistical regression yields the so-called "equity" beta. It is common practice in network regulation and the financial industry to adjust the raw equity betas that result from the regression to account for potential biases.

3.5.1. Methodological considerations

Refining beta adjustments is a topical strand of academic research.[40] The two common adjustments are the Blume-adjustment and the Vasicek-adjustment. The Blume-adjustment originates in Blume's observation in the 1970s that equity betas exhibit mean-reversion.[41] This means that finding a low equity beta in one period for a given stock increases the likelihood of finding a higher equity beta in the next period for that stock. Specifically, Blume finds that the beta for the next period is best forecasted by a weighted average of the estimated equity beta (weight of two thirds) and the average market beta of one (weight of one third).

Building on Blume's findings, Vasicek shows that the mean-reversion occurs even if the "true" beta is unchanged.[42] This implies that observing particularly low or particularly high betas is sometimes a result of pure chance. Raw, i.e. unadjusted, regression estimates may be misleading. Vasicek's key finding is that the probability of estimating a biased raw beta increases with the magnitude of the regression standard error. Consequently, Vasicek proposes an adjustment where the beta is calculated as weighted average between an a-priori expectation and the raw regression estimate. The weight on the raw regression estimate decreases with the magnitude of its standard error, i.e. becomes lower as uncertainty about the raw regression estimate increases. This so-called "Vasicek-adjustment" corrects for statistical errors.

The use of either the Blume-adjustment or the Vasicek-adjustment is widespread in academic research, the financial industry and network regulation. For instance, the leading providers of financial data, Bloomberg and Thomson Reuters, both report company betas as adjusted betas by default.

An alternative approach to adjusting raw beta estimates is by excluding observations with a particularly low explanatory power (e.g. based on R^2 or a t-test). Low explanatory power suggests a weak relationship between the dependent and the independent variable and may be caused by random variations in the data.

[40] See for example: Goldberg, Papanicolaou, Shkolnik, Ulucam (2019): Better Betas, Working Paper.

[41] Blume (1971): On the assessment of risk, Journal of Finance, 26, 1–10.

[42] Vasicek (1973): A note on using cross-sectional information in Bayesian estimation of security betas, Journal of Finance, 28, 1233–1239.

In the regulatory context, it is sometimes debated whether adjusting the raw equity betas towards the market average of one is appropriate given the seemingly lower business risk compared to other sectors. However, the equity beta is not solely determined by pure business risk but also by financial and operating leverage. Firms with a relatively large share of debt or a high share of fixed costs will also exhibit a higher equity beta. Both is arguably the case for network operators.

Table 3.5
Beta Adjustment[43]

Country	Year	None	Blume	Vasicek
Austria	2018			✓
Belgium (DSO)*	2019		✓	
France	2016			✓
Germany	2016			✓
Italy	2018		✓	
Luxembourg	2016			✓
Netherlands	2016			✓
Portugal	2017		✓	
Spain	2019	✓		
Sweden	2019	✓		

** Wallonia (Flanders uses the Dimson-adjustment)*

Source: NERA analysis. Several countries rely on alternative adjustment mechanisms, see text.

Table 3.5 shows precedent cases from international network regulation. Of the eight regulators relying on probability-based adjustments, seven adjust betas using either Blume-adjustment or Vasicek-adjustment when determining betas. Only the Spanish regulator did not adjust the raw beta.[44] The use of Vasicek-adjusted betas in the regulatory context was subject to legal proceedings in Germany. The German Federal Supreme Court has confirmed the use of the Vasicek-adjusted betas in the regulatory context.[45]

Several countries use alternative mechanisms to correct for potential bias in the regression. Switzerland discards observations with low statistical significance, based on a t-test. Similarly, Finland excludes estimates with low explanatory value (R^2), an approach that has been used by

[43] The United Kingdom is omitted in this table because the British discussion is ongoing and evolves around using alternative models to estimates betas (GARCH), instead of adjusting betas resulting from ordinary least squares (OLS) regressions. The British regulator Ofgem considers additional economic information and does not rely exclusively on its empirical estimation.

[44] However, the Spanish regulator uses a large sample of 29 comparators, which reduces the influence of random variation in individual company data, while Sweden relies on only 5 comparators (see Table 3.1).

[45] See Bundesgerichtshof (2015): Decision EnVR 42/13.

the Swedish regulator in the past.[46] Belgium's national regulator relies on a lower bound for its empirical beta calculation.

Our preferred approach is to adjust equity betas using the Vasicek-adjustment, since it has a clear theoretical foundation and explicitly considers the estimation uncertainty expressed by the regression standard error.

3.5.2. Application of the ordinance

The Swedish ordinance does not specify any details on beta adjustments. Due to the developing methodology in empirical beta estimation, we think it is sensible to leave potential adjustments open and consider current regulatory practice and academic decisions before committing to a specific approach. Following the discussion above, we propose to apply the Vasicek-adjustment to raw equity betas.

Complementary to adjustment, filtering is appropriate for some of the sampled comparator companies and some years. In chapter 3.1.2 we discuss why we exclude E.ON from the sample. Similar reasoning also applies to Elia in the years 2009 and 2010. Elia has not been used as comparator for the previous regulatory period from 2012 to 2015 in Germany. In 2011, the consultant commissioned by the regulator concluded that Elia should be eliminated from the sample of comparators. As enquired and confirmed by the Belgian regulator at the time, Elia's regulatory framework incorporated several mechanisms aiming to eliminate the risk of cost-underrecovery. These features, which do not exist in Sweden or Germany, reduced Elia's business risk and hence the estimated betas. The German regulator's consultant found that these low betas are not reflective of regulated network operators in other jurisdictions.[47] The German regulator revised this assessment and relied upon Elia as a comparator company after Elia's acquisition of large stakes in the German network operator 50-Hertz (2010 and 2018).

The Belgian regulator responsible for Elia is aware of the potentially unrepresentative low beta and relies on a lower bound for its beta-determination. If the empirically estimated equity beta is below 0.53, this lower bound is set as the appropriate equity beta instead. In the Swedish beta determination, which includes the years 2009 and 2010 in its time period, it should be reassessed whether Elia's asset beta values (i.e. after unlevering, see chapter 3.6) for the years 2009 and 2010, which are in the range from 0.01 to 0.22,[48] reflect the current risk profile of Swedish electricity network operators. Following the above discussion, we prefer to exclude Elia in 2009 and 2010.

[46] See EY (2015) Energimarknadsinspektionen: WACC för elnätföretag för tyllsysperioden 2016-2019

[47] Frontier Economics (2011): Wissenschaftliches Gutachten zur Ermittlung des Zuschlages zur Abdeckung netzbtriebsspezifischer unternehmerischer Wagnisse im Bereich Gas, p. 45f.

[48] Montell & Partners (2019): Parametrar till bedömning av kalkylränta för elnät 2020-2023, p. 19.

In addition, given the long time period prescribed by the ordinance, the results of the estimates should be analysed carefully to understand whether structural breaks or economic conditions may influence or bias the results (see chapter 3.2.1 for a more detailed discussion), which may require additional filtering.

3.5.3. Comparison with Ei

The Swedish regulator Ei does not make any adjustment and does not discuss beta adjustments in the regulatory decision. Ei's finding of an asset beta 0.29 is at odds with international precedent cases (see Chapter 4.1 for detailed discussion) and raises the question whether the beta estimate may be influenced from random statistical errors. The beta-adjustments serve the exact purpose of correcting the raw beta estimate for such errors when it deviates from a-priori expectations. Therefore, it is inappropriate that the Swedish regulator has not adjusted raw equity betas.

Montell & Partners recommend filtering of the results based on the explanatory value of the beta-regression. The consultant filters the beta based on statistical criteria and eliminates beta estimates with a R^2 of less than 0.3. This approach was also used by the Finnish regulator. Similarly, the Swiss regulator discards observations based on a t-test.[49].

The Swedish regulator discusses the filtering performed by its consultant in the decision and considers it unnecessary. According to the Swedish regulator, not including all data would mean not using the available information in an optimal way.[50] This assessment relies on the assumption that all input data is representative of the risk of Swedish network operators. As discussed before, this may not be the case. Given the methodological choices prescribed by the ordinance and discussed above, proceeding to use the raw beta value (without filtering) is contrary to best practice and economic theory.

3.6. Unlevering Equity Betas

Equity betas resulting from the statistical regression reflect the business risk and the financial risk of the comparator companies. The financial risk is closely related to the financing structure, i.e. the shares of debt and equity. The financing structures of the comparator companies are different from the 51% equity share assumed by Ei when calculating the WACC (see Table 1.1). Therefore, the equity betas are corrected for company-specific financing structures and tax rates.

[49] It can be shown that this has the same effect as filtering by R^2.

[50] Energimarknadsinspektionen (2019) Bilaga 7: Kalkylränta för elnätsföretag, För tillsysnsperioden 2020 – 2023, p. 10

3.6.1. Methodological considerations

When comparing different companies from different countries to assess the riskiness of Swedish network operators, their specific financing structures and tax rates must be considered, since they influence beta estimates. Accounting for these differences yields the so-called "asset beta", which represents the relative riskiness of network activities, independent of gearing and variations in tax rates.

Increasing debt ratios make equity investments riskier, because the equity holders' claims on the cash-flows generated by a company are subordinated to those of debt holders. To distinguish the business risk of the network operations from risk induced by taking on debt, the companies' different financing structures must be controlled for.[51] In addition, interest rates paid for debt are generally tax-deductible, whereas profits must be taxed. According to the Modigliani-Miller theorem, raising financial debt then creates value to equity holders in the form of tax savings.[52] Since tax rates – and therefore tax savings – differ between countries, it is important to account for taxes when comparing companies from different countries.

In practice, the Hamada-formula is used to "correct" (or "un-lever") the equity betas of the comparator companies for their respective financial leverage, i.e. the amount of debt relative to equity, and differences in tax rates as shown below:

$$\beta_{asset} = \frac{\beta_{equity}}{\left(1 + (1 - tax\ rate) * \frac{debt}{equity}\right)} .$$

A higher share of debt relative to equity increases the denominator and hence the difference between the asset beta and equity beta. If a company has no debt, the denominator is equal to one and the equity beta equals the asset beta. The second parameter that impacts the relationship between the equity beta and the asset beta is the tax rate. The higher the tax rate, the higher the asset beta given a certain equity beta.

3.6.2. Application of the ordinance

The Swedish ordinance does not explicitly specify how to unlever equity betas. Paragraph 25 of the ordinance prescribes the use of "current tax rates". This points towards the Hamada-formula to account for the different tax rates in the comparator's home countries.

The level of taxes influences a company's net profits and therefore its share price and the beta. It is therefore important to evaluate each company with its respective national tax rate in each

[51] For a more detailed discussion, see for example: Richard Brealey and Sewart Myers (2000) Principles of Corporate Finance. Sixth Edition. McGraw-Hill Higher Education, Chapter 9.2 p. 228-231

[52] For a more detailed discussion, see for example: Richard Brealey and Sewart Myers (2000) Principles of Corporate Finance. Sixth Edition. McGraw-Hill Higher Education, Chapter 18.1 p. 500-504

year for which observations are included. Using yearly regressions to estimate betas simplifies unlevering and the choice of appropriate tax rates.

3.6.3. Comparison with Ei

Ei interprets "current tax rate" to mean the 2018 tax rate. Against Montell & Partners' explicit recommendation, Ei decides to apply the tax rates from 2018 of the comparators' home countries for the entire ten-year period. The 2018 tax rate is used to unlever all equity betas which are estimated separately for the years 2009 to 2018. The Swedish regulator argues that this would be the most obvious interpretation of the ordinance. It is, however, methodically and economically incorrect.

Combining equity betas and tax rates from different points in time is methodologically incorrect, because market participants base their investment decision on the current tax rate. Hence, the price data from which equity betas in a particular year are estimated reflects that year's tax rate. The equity beta for a given company in a given year would have been different, if the tax rate had been different. For example, National Grid's estimated equity beta for 2009 would have been higher, had the corporate tax rate been 20% (2018 value) instead of 28% (2009 value). Unlike all other European regulators, who (to our knowledge) use tax rates consistent with the estimation period, the Swedish regulator ignores this fundamental relationship between stock valuation and tax rates.

All home countries of the comparator companies, i.e. the United Kingdom, Italy, Spain, Belgium and Portugal, have decreased their corporate tax rates over the period 2009 to 2018.[53] Therefore, the Swedish regulator's erroneous treatment of taxes results in an underestimation of the asset beta. This error is compounded by using an exceptionally long time period of ten years for beta estimation.

We understand that the Swedish ordinance may be ambiguous regarding the interpretation of "current" tax rate. Nonetheless, the use of the 2018 tax for a ten-year period in which tax rates were repeatedly adjusted is inappropriate. In its attempt to strictly follow the ordinance, Ei discarded sound economic advice from its consultant. This highlights the danger of highly detailed, yet ambiguous prescriptions. Following the natural economic interpretation of "current tax rates" in this context, we strongly advise to apply the appropriate yearly corporate tax rates throughout the observation period.

[53] See https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/corporate-tax-rates-table.html [9/12/2019].

4. Remarks on Ei's Asset Beta Decision

The previous chapter discusses methodological aspects of the beta determination. The Swedish ordinance contains detailed prescriptions on many of these aspects. Nonetheless, Ei has to interpret the ordinance and take methodological decisions in some instances.

After assessing the ordinance and Ei's approach, it is clear that Ei consistently interpreted the ordinance in a way such that i) the available information or data is reduced, or ii) the methodological decisions reduced the beta compared to regulatory precedent and our economic assessment.

- Ei relies on the smallest sample of comparators (even excluding Transelectrica) of any European regulator and does not include any DSOs.
- Ei uses only Friday-Friday returns only, discarding information from all other weekdays.
- Ei does not adjust or filter raw equity betas.
- Ei uses 2018 tax rates for the entire ten-years period, despite tax rate reductions in all home countries of the comparators during the observation period.
- Ei weighs each observation equally and does not further investigate whether all observations are representative.

Together, these methodological choices result in an asset beta of 0.29 for Swedish electricity network operators. As discussed before, empirical beta estimations are sensitive to the exact methodological specifications and do not necessarily reflect the "true" beta. In addition to testing alternative specifications (as estimated by Montell & Partners), it is effective to consider additional information to validate the estimated betas and confirm their validity. The ordinance does not prescribe any further comparisons, however, validating initial estimates with additional sources of information, e.g. decisions by other European regulators, is essential to ensure the quality of the empirical estimate.

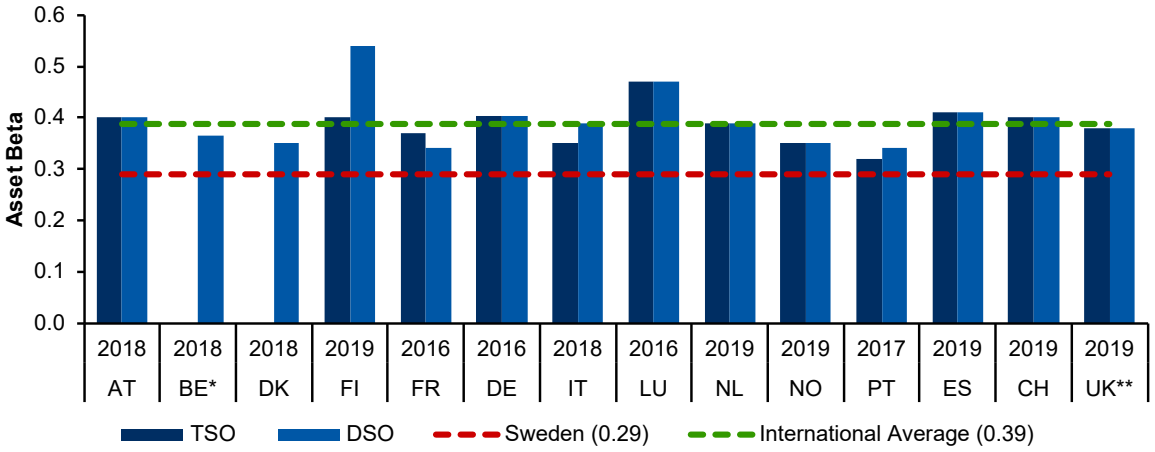
To assess the plausibility of the determined beta, we compare this value to international precedent cases (Chapter 4.1) and the betas used by financial analysts for the stocks of E.ON and the five comparator companies used by Ei (Chapter 4.2).

4.1. Ei's Beta-Determination in the European Context

Network operators are regulated in most European countries. Consequently, many regulators face the same challenge of setting the WACC and hence the appropriate beta for regulated electricity network operators. As discussed in Chapter 3, the Swedish ordinance and Ei's

interpretation deviate in several relevant methodological decisions from European precedent and result in a lower beta.

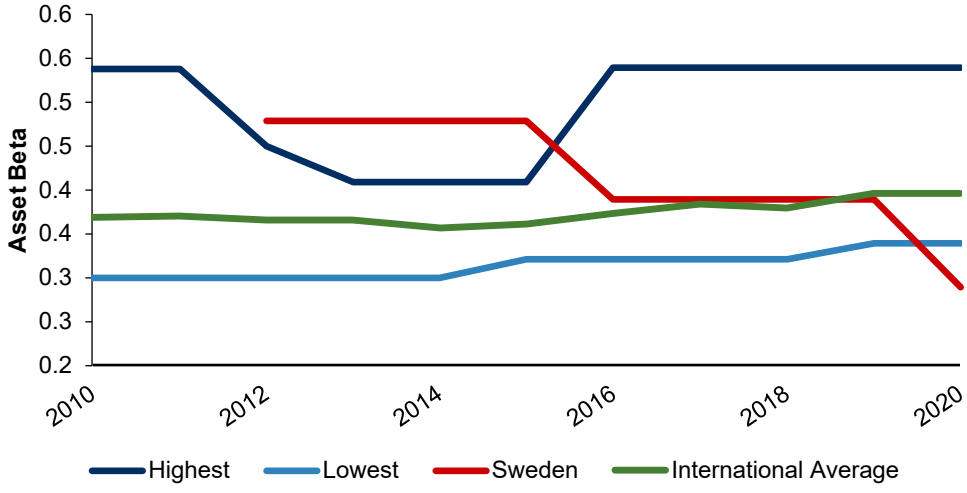
Figure 4.1
Asset betas set by European regulators



* Average of regional beta coefficients ** Methodology decision of the ongoing consultation process for the RIIO-2 Framework. *Source: NERA analysis*

Figure 4.1 compares the Swedish beta determination with the most recent decisions by other European regulators. The comparison illustrates that the Swedish decision is the lowest beta decision in Europe. The average difference amounts to 0.10, or more than a third of the Swedish value. The second lowest country average from Portugal is still 0.04 (or 14%) higher than the Swedish beta decision. Considering that each of the European regulators faces the same objectives and methodological trade-offs, the difference is remarkable.

Figure 4.2
Developments in European Asset Beta Determinations



Source: NERA analysis

A similar finding is illustrated by Figure 4.2, which shows the evolution of beta determinations in European countries over time. Sweden and Portugal are the sole two countries where the beta-coefficient determined by regulators has decreased over time. The international average of asset betas (0.37 in 2010) declined marginally to 0.35 by 2014, before steadily increasing to 0.40 in 2019. The latest decision by Ei places Sweden below the entire range of European precedent. The Swedish beta is therefore at odds with European precedent, regarding the absolute value as well as regarding the trend.

The Swedish asset beta of 0.29 is based on a comparator sample consisting of National Grid (United Kingdom), Terna (Italy), Redes Energeticas Nacionais (Portugal), Red Electrica (Spain) and Elia (Belgium). These comparator companies are transmission system operators in their respective countries and hence regulated by local authorities. Therefore, local regulators regularly assess the risk of these companies and determine the beta when setting their regulatory cost of capital. The asset betas which Ei estimates for each of the comparators are also lower than the beta determinations for the same companies by their respective regulators.

Table 4.1
Local Asset Betas Calculated for Comparators

Company	Year	Swedish beta assessment	Local beta decision	Difference
Elia Systems Operator	2018	0.18	0.26**	0.06
Terna	2018	0.32	0.37	0.05
Redes Energeticas Nacionais	2017	0.20	0.32	0.12
Red Electrica Corporation	2019	0.43	0.41	-0.02
National Grid	2019*	0.33	0.38	0.05
Average		0.29	0.35	0.06

** Methodology decisions of the ongoing consultation process for the RIIO-2 Framework*
*** Calculated from the lower bound of the equity beta (0.53), may be higher in practice*
Source: NERA analysis

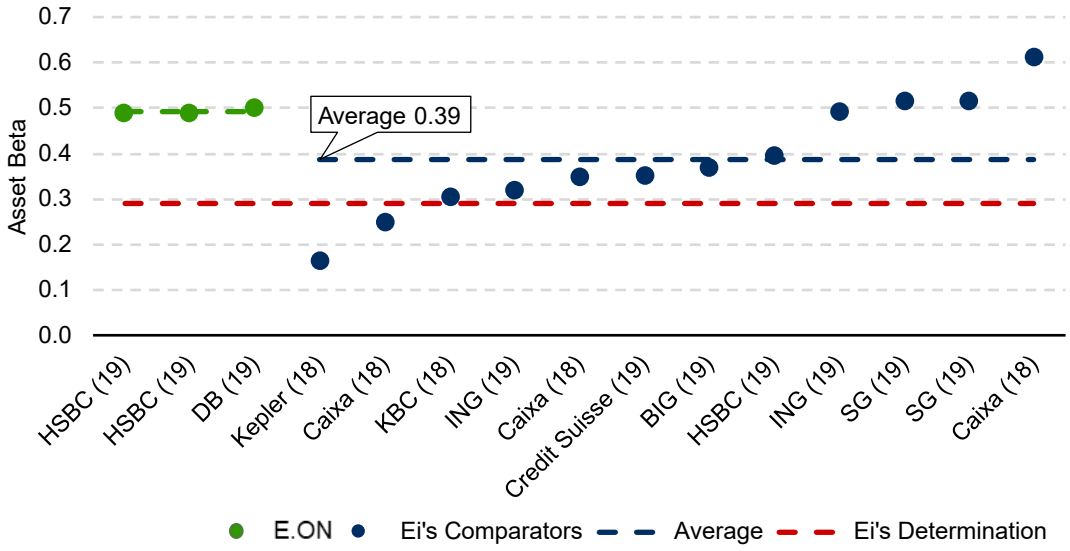
Table 4.1 summarises the asset beta estimates of the Swedish regulator for each of the comparator companies, as well as the applied asset betas determined by the respective local authorities. For each of the comparator companies except in Spain (where the regulatory authority uses a six-year period for estimation instead of ten years, see Chapter 3.2.1), the responsible national regulator finds a higher beta than the Swedish regulator. The substantial difference between the Swedish and the Portuguese regulators in their assessment of REN is noteworthy, because the Portuguese regulator Erse carefully disentangles the regulated electricity transmission operations from RENs other business activities. The average of the beta determinations by the five national regulators is 0.35, compared to Ei's determination of 0.29.

4.2. Ei's Beta Determination in the Context of Financial Markets

Research reports on network operators by financial analysts are a useful additional benchmark for assessing the Swedish beta determination. In their reports, financial analysts assess whether the stock price of a company reflects its expected earnings. If an analyst finds that the stock price is lower than discounted expected earnings, the analyst will issue a buy-recommendation (and vice versa). When discounting expected earnings, financial analysts use a WACC. This WACC reflects their assessment of the risk when investing in network operators.

The WACC and the included beta-coefficient used by financial analysts is directly relevant for regulatory decisions, because the regulatory WACC is an estimate of the return required by investors. Investors on the other hand base their investment decision on research reports by financial analysts. Hence, the WACCs and betas underlying these reports are decisive for network operators trying to attract the necessary capital.[54] Network operators will not be able to attract capital, if the allowed return is below the return required by investors.

Figure 4.3
Asset Betas from Analyst Reports



Source: NERA analysis. The analyst reports used for this comparison are listed in Appendix D.2.

[54] The research reports are commonly issued by large investment banks. Investment banks represent the so-called "sell side", meaning they try to sell stocks and other financial products to the general market. It is sometimes claimed that the financial research reports do not reflect the true view of financial analysts because the role of investment banks in financial markets would incentivise biased assessments. If this were the case, financial analysts would have an incentive to issue buy-recommendations. Buy-recommendations are issued when the discounted expected earnings are higher than the current stock price. The value of discounted expected earnings is negatively related to the WACC, i.e. a lower WACC increases the present value of discounted expected earnings and hence the likelihood of a buy-recommendation. Therefore, the potential bias that financial analysts may have would lead to an underestimation of the WACC.

Figure 4.3 shows the beta-coefficients estimated by financial analysts for E.ON and the comparators used by Ei. We analysed 28 analyst reports issued by 14 investment banks.[55] The above chart shows that financial analysts from HSBC and Deutsche Bank consider an asset beta of approximately 0.50 reflective for E.ON's business risk relative to the market. Due to the recent restructuring of E.ONs business, the most recent analyst report by Deutsche Bank considers E.ON as network operator with 81% of its enterprise value coming from regulated energy networks (mostly in Germany and Sweden). Similarly, almost all financial analysts find the asset beta of the comparator companies to be higher than 0.29. The average asset beta of the peer group relied upon by financial analysts is 0.39.

4.3. Summary

Assessing Ei's beta determination to other practitioners can reveal potential bias in the estimate of the "true" beta. The average asset beta of the European countries analysed for our report is 0.39. The average asset beta relied upon by financial analysts recently is also 0.39. Montell & Partners recommend an asset beta of 0.37 in their report, which is within the range of European precedent cases and the financial analysts estimates. Ei sets an asset beta of 0.29, which is at odds with all precedent cases considered.

The methodological discussion in Chapter 3 shows that Ei deviates from precedent cases and economic theory – sometimes against the advice of their own consultants. Ei's beta-determination reflects a narrow and one-sided interpretation of the ordinance which is itself suboptimal from an economic point of view. The resulting beta likely reflects methodological errors and likely underestimates the risks of electricity network operators in Sweden.

[55] The analyst reports usually provide equity beta estimates, we therefore unlever these betas to increase comparability and derive the asset beta following the methodology presented in Chapter 3.6. Not all analyst reports contain detailed WACC figures, the number of reports in Figure 4.3 is therefore lower.

5. Recommendation on Asset Beta

Following the methodological discussion in Section 3, this chapter quantifies the beta under our preferred approach subject to the constraints of the ordinance. As discussed, even within these constraints, the beta-coefficient is sensitive to certain assumptions and decisions of the chosen specification.

To identify the most likely "true" beta, we propose to analyse the initial results by comparing them with a range of alternative specifications and subsequently validate the estimates with additional information introduced in Section 4. The following section includes our baseline estimate, according to the derived estimation approach (Chapter 5.1), alternative specifications, to validate the baseline estimate (Chapter 5.2), and an external validation using additional sources of relevant information (Chapter 5.3).

5.1. Baseline Estimate

The baseline estimates are derived with the following specifications, based on the Swedish ordinance as discussed in Chapter 3:

- *Comparators*: National Grid Plc, Terna S.p.A., Redes Energeticas Nacionais S.A., Red Eléctrica Corporación S.A., Elia System Operator S.A., Transelectrica S.A., Iberdrola S.A., and Endesa S.A.
- *Data Period:* 2009-2018, yearly regressions
- *Reference index*: MSCI World Index
- *Return*: average of weekly returns for each day of the week
- *Beta-adjustment*: Vasicek-adjustment
- *Unlevering*: Modigliani-Miller asset betas, using yearly corporate tax rates
- *Filtering*: Elia is excluded in 2009 and 2010, due to incomparable regulatory framework

The results of these estimates are shown for each company in Table 5.1.

Table 5.1
Modigliani-Miller Asset Betas[56]

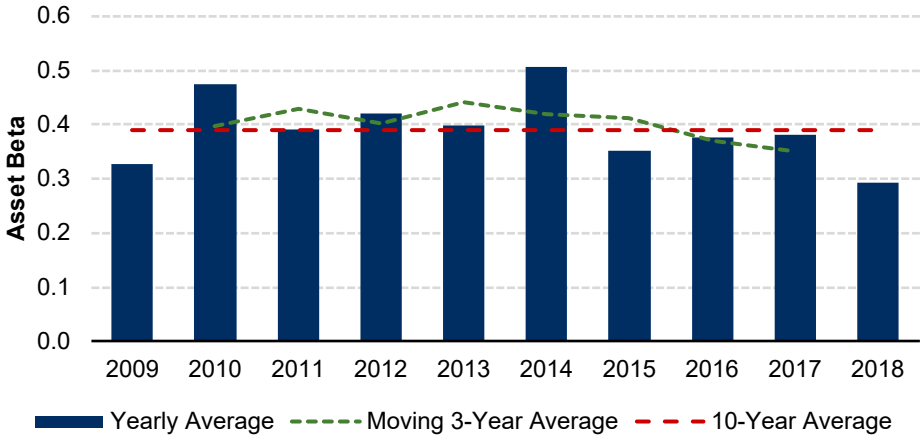
Company	Country	Average (10 years)*
Terna	Italy	0.31
Red Electrica	Spain	0.45
Elia	Belgium	0.24
REN	Portugal	0.18
National Grid	United Kingdom	0.34
Transelectrica	Romania	0.44
Iberdrola	Spain	0.50
Endesa	Spain	0.65
Average		**0.39**

*Source: Nera analysis. *Year 2009 and 2010 excluded for Elia.*

The average asset beta over ten years and all companies is 0.39. There is substantial variation within the sample of comparators. The lowest average beta is estimated for the Portuguese TSO REN (0.18), the highest for the Spanish energy company and DSO Endesa (0.65). As discussed in Chapter 4.1, the estimated beta for REN is substantially below the asset beta determined by Portuguese regulator Erse. Similarly, the asset beta estimated for Elia is below the lower bound set by Belgian regulator and may not be reflective of the risk of Swedish network operators (see discussion in Chapter 3.5.2). The influence of Endesa and REN is further investigated in the next chapter.

Figure 5.1 shows the sample averages over time.

Figure 5.1
Average Yearly Asset Beta Estimates



Source: Nera analysis. Years 2009 and 2010 excluded for Elia.

[56] Values for the yearly estimates can be found in Appendix C.

The estimates exhibit significant variation between observed years. Figure 5.1 shows especially low estimates in 2009 and 2018, and the highest estimates in 2010 and 2014. Accordingly, the moving 3-year average fluctuates around the 10-year average.

5.2. Alternative Specifications

To assess the plausibility and sensitivity of the initial estimates to our specific methodological choices, we cross-check the result with several additional specifications. The following alternative specifications are considered:

- Alternative sample of comparators by removing outliers from the initial sample to increase the quality of the observations
- Using an alternative global index (S&P Global 1200) as reference index
- Calculating Friday-Friday returns only
- Adjusting raw equity betas with the Blume-adjustment instead of the Vasicek-adjustment
- Estimating a single ten-year regression for each company instead of yearly regressions
- Analyzing additional time periods (3, 5 and 7 years)

Table 5.2
Asset Betas with Alternative Specifications

Specification	Asset beta
Excluding Endesa & REN	0.38
S&P Global 1200 Index	0.39
Friday-Friday returns	0.38
Blume adjustment	0.45
Single 10-year Regression[57]	0.35
Average 2012-2018	0.39
Average 2014-2018	0.38
Average 2016-2018	0.35
Range:	**0.35-0.45**

Source: Nera analysis

The results of these additional specifications are shown in Table 5.2. The estimated betas in the different specifications range from 0.35 to 0.45. Most of the alternative specifications yield very similar results and strengthen the initial estimation approach. More specifically:

[57] For Elia, the regression is calculated for the eight-year period 2011-2018.

- Excluding the comparators with the lowest and highest betas, REN and Endesa, as outliers from the sample yields an average beta of 0.38, which is very similar to the initial estimate and suggests a limited influence of outliers within the sample of comparators.
- Using the S&P Global 1200 Index as alternative reference index does not change the previous results (0.39).
- Exclusively relying on Friday-Friday returns leads to a slightly lower estimate of 0.38 over the ten-year period, which suggests that Ei's approach slightly reduces the beta estimate by discarding useful information (see discussion in Chapter 3.4.1).
- Adjusting raw equity betas with the Blume-adjustment instead of the Vasicek-adjustment increases the beta estimate to 0.45, which is the result of the greater weight of the market average of one (see explanation in Chapter 3.5.1).
- Calculating single, ten-year regressions for each company reduces the beta estimate to 0.35. This is partially due to the smaller standard error and hence lower adjustment of the estimated beta.[58]
- Considering different time periods shows that shorter periods reduce the estimates, due to the greater weight of the relatively low estimate for 2018 (compare also Figure 5.1). Considering 2018 in isolation therefore likely underestimates asset betas (it is also not permitted by the instructions of ordinance).

Our initial estimate of 0.39 is in the middle of the range of alternative specifications and very close to most of them. The three greatest deviations are derived by using the Blume-adjustment, calculating a single ten-year regression, and by shortening the time period to three years. The relatively low sensitivity to the most critical methodological decisions (eliminating comparators from the sample and analysing different time periods) corroborate the initial findings and suggest that potential biases in the selection of comparators offset each other despite the relatively small sample. The conclusion is supported by calculating the median instead of the mean for the comparator companies, which is also 0.39. The alternative specifications therefore strengthen our results and the validity of the estimation approach.

5.3. External Validation

To cross-check our results with external information, we compare our estimates to three relevant external sources of information: European precedent, financial analyst reports, and the results obtained by Montell & Partners.

[58] The Vasicek-adjustment depends on the size of the standard error of the regression.

European precedent

As discussed in Chapter 4.1, the Swedish decision 0.29 was substantially lower than the European average asset beta determination of 0.39. European country averages for DSOs and TSOs range from 0.33 (Portugal) to 0.47 (Finland and Luxembourg). Our estimate of 0.39 is identical to the average and our estimation range is within the range of European determinations.

The evolution of European beta determinations also supports a higher asset beta-coefficient than Ei's decision. In the most recent determinations almost all regulators increased asset betas, or at least held them constant. The most recent Swedish beta decision is the lowest in Europe and merits scepticism regarding its validity. The above estimate on the other hand is within European precedent and within recent trends.

Financial analyst reports

Evidence from financial analyst reports is discussed in detail in Chapter 4.2. The average beta estimate is 0.39 (instead of 0.29 as determined by Ei).[59] Although our sample of comparators differs marginally, the similar results support our estimation approach.

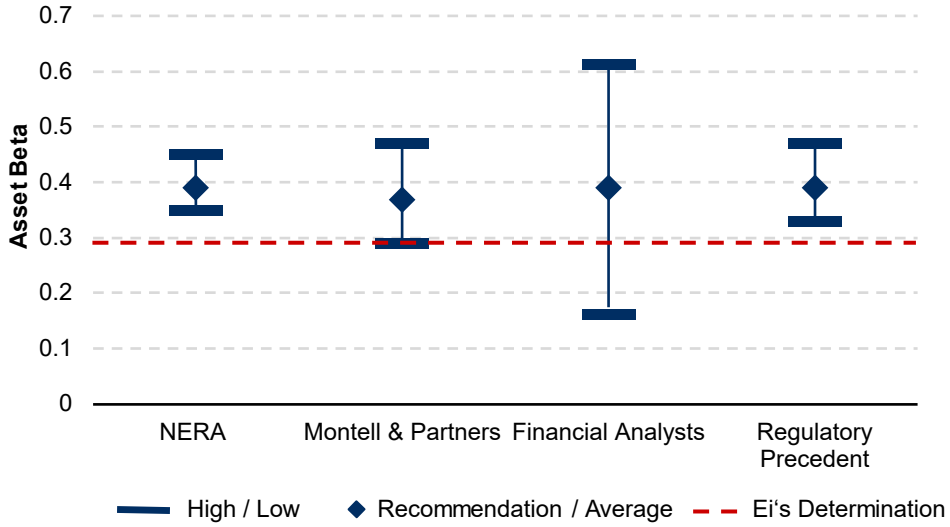
Montell & Partners

As discussed before, Montell & Partners estimate asset betas in several specifications, closely following the Swedish ordinance. Their estimates range from 0.29 (using all observations with the MSCI World Index and the 2018 tax-rates for all years) to 0.46 (excluding observations with an $R^2 > 0.3$). Montell & Partners argue that a European stock index is the most appropriate benchmark and, additionally, that all observations with a low explanatory power should be disregarded. The asset beta recommended by Montell & Partners for Swedish electricity network operators is 0.37. This value is very close to our own central estimate of 0.39.

As discussed before, estimating the "true" beta for Swedish electricity network operators is influenced by the specific methodological decisions and selected data. Comparing our empirical estimate to European precedent, research by financial analysts and the estimates by Montell & Partners shows a clear pattern. Figure 5.2 summarises the results from the various sources.

[59] Based on the comparators used by Montell & Partners.

Figure 5.2
Comparison of Beta Estimates



Source: NERA analysis

Figure 5.2 shows that the range of our estimates is within the range of alternative estimates and all recommendations and averages align between 0.37 (Montell & Partners) and 0.39 (financial analysts, regulatory precedent and our estimate). The considerations and findings increase our confidence in our methodological specification and the resulting beta.

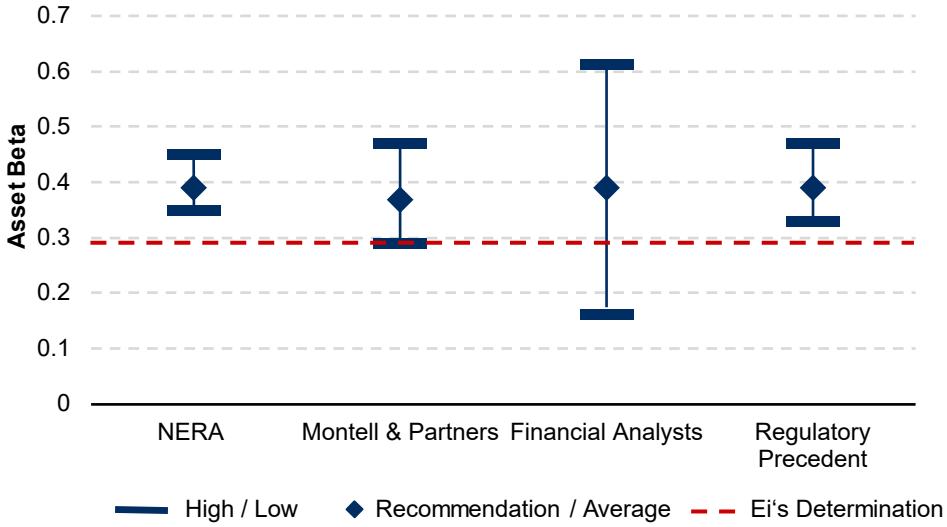
6. Conclusion

This report assesses the Swedish Ordinance 2018:1520 and Ei's beta determination based on its detailed instructions. From an economic point of view, there are risks in substantially restricting the discretion of the regulatory authority. The ordinance severely limits Ei's ability to respond to changes in market conditions, hold open consultations with stakeholders and ultimately determine an appropriate regulatory cost of capital in line with best practices and economic theory. Our main findings include the following:

- The ordinance includes several specific instructions, which are not aligned with current economic theory. For example, the restrictions on the selection of comparators likely prevent Ei from analysing all useful and available information. Ei is also alone in relying on a global reference index to calculate betas.
- Despite its detailedness, the ordinance does not prescribe all methodological aspects of beta determination, thereby leaving Ei with regulatory discretion in some respects. Our review of the beta determination shows that on several occasions, Ei chooses methodological options which additionally reduce the amount of useful data. Ei's methodological decisions consistently reduce the estimated beta as evidenced by the lack of adjustment or the use of wrong tax rates. On several occasions, Ei does not follow the explicit recommendations of their consultants.
- Consequently, the beta of 0.29 set by Ei is the lowest such determination among European regulators. The beta is 0.10 or 26% below the European average. The Swedish determinations is also at odds with a trend of increasing beta values for regulated networks.
- A beta derived according to the instructions in the ordinance but more in line with economic theory and best-practices (whenever permitted under the ordinance) amounts to 0.39. This value is close to the European average and supported by a sensitivity analysis and several cross-checks.

Determining betas based on empirical estimation relies on assumptions and methodological choices which influence the estimated beta. To identify potential bias, the results should be validated using alternative estimation specifications as well as external sources of information. Figure 6.1 compares Ei's decision with our estimates, the recommendations by Montell & Partners, the research of financial analysts, and the decisions of other European regulators.

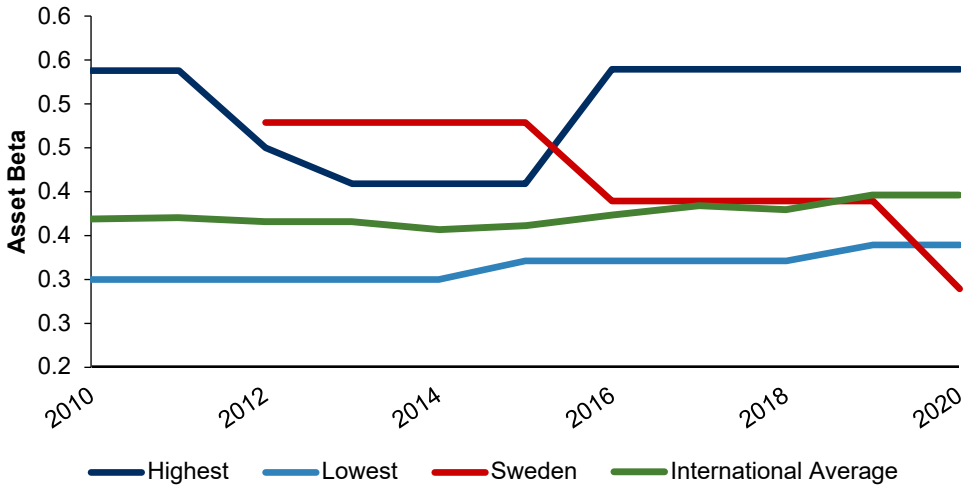
Figure 6.1
Comparison of Beta Estimates



Source: NERA analysis. Identical to Figure 5.2.

We estimate an asset beta of 0.39 with a range from 0.35 to 0.45. Our derived beta value is identical to the European average as well as the average beta estimated by financial analysts for the group of five comparators identified by Ei. Montell & Partners recommend an asset beta of 0.37, which is also very similar to our estimate despite a different approach. Ei's determinations is significantly below all benchmarks.

Figure 6.2
Developments in European Asset Beta Determinations



Source: NERA analysis. Identical to Figure 4.2.

In addition to the deviation from current regulatory practice, the beta determination by Ei conflicts with the recent trend in European regulatory practice. Figure 6.2 shows that beta-coefficients determined by other regulators increased over recent years.

Ei provides no reasoning for the sharp decrease of the beta relative to previous regulatory periods or the difference to international beta determinations. Network business in other European countries, where betas are significantly higher, is not riskier than network business in Sweden. Instead, the low Swedish beta value results from a suboptimal methodology. The beta-coefficient determined by Ei does not appropriately reflect the risk of Swedish electricity networks.

Appendix A. Reference Index

To expand the discussion in Chapter 3.3.1, this appendix includes an explanation of the issues with using a global reference market. We discuss the issue of home bias, the relationship between risk and correlation in international diversification, and of lower correlation due to different trading hours.

Home Bias

In theory, unrestricted international capital markets should lead to similarly differentiated investment portfolios. There is evidence for a systematic home bias among investors, who tend to overinvest in domestic markets. While home bias decreased within the European monetary union since the introduction of the Euro, distance still plays an important role in asset allocation even for Eurozone investors.[60] For this reason, using a reference index that consists mostly of non-domestic (and non-European) stocks appears contrary to market reality.

Furthermore, correlation between European and American stock markets have increased, thereby reducing the benefits of international diversification between the two regions.[61] Greater global integration of financial markets and internationalisation of large corporations usually listed in national indices mean that European stock indices contain a substantial degree of international diversification. In addition, there is evidence that correlations between European and American stock markets are especially strong during crisis episodes,[62] the very moment when a globally diversified portfolio is supposed to reduce systematic risk. Lastly, it should be noted that domestic stock indices include substantial international diversification due to the business activities of the listed companies and therefore reduce the effects of a home bias.[63] Choosing a global stock market to approximate a globally diversified investment portfolio appears inappropriate as well as unnecessary from this perspective.

Lower Correlation Does Not Imply Lower Risk

The beta measures the correlation of stock returns with the returns of a reference index. A low correlation suggests lower risk, whereas a stronger correlation suggests higher risk. When assessing the risk of a European utility relative to the global market, using the MSCI World index

[60] Jochen and Volz (2011): Portfolio holdings in the euro area – home bias and the role of international, domestic and sector-specific factors; Deutsche Bundesbank, Discussion Paper Series 1: Economic Studies No 07/2011

[61] See for example: Christoffersen et al. (2012): Is the Potential for International Diversification Disappearing? A Dynamic Copula Approach. The Review of Financial Studies, Volume 25, Issue 12. Pages 3711–3751

[62] BenMim and BenSaïda (2019) Financial contagion across major stock markets: A study during crisis episodes. The North American Journal of Economics and Finance, Volume 48. Pages 187-201.

[63] Oehler, Wendt and Horn (2017) Are investors really home-biased when investing at home? Research in International Business and Finance 40 pp. 52-60

is not the optimal benchmark. The index consists predominantly of US-American companies – approximately 63% of the index weight, and a further 8% are from Japan.[64] Due to this weighting, which reflects the relative size of capital markets, stocks from outside the US will exhibit a relatively low correlation. This, however, does not imply that they are of lower risk compared to otherwise similar stocks from the US – not even from a global perspective.

In a similar manner, finance scholar Aswath Damodaran argues that using a global index to calculate betas leads to biased estimates for developing countries. By estimating the relative volatility of the largest companies, he finds that companies from India or Brazil have lower betas than companies from Japan or the US, suggesting lower risks and lower costs of capital – a highly implausible result.[65] Again, these results are due to less than perfect correlations between the US equity market and other equity markets. The use of the MSCI World by Ei introduces a similar bias, because – like the developing countries in Damodaran's analysis – Sweden has a relatively low market capitalisation.

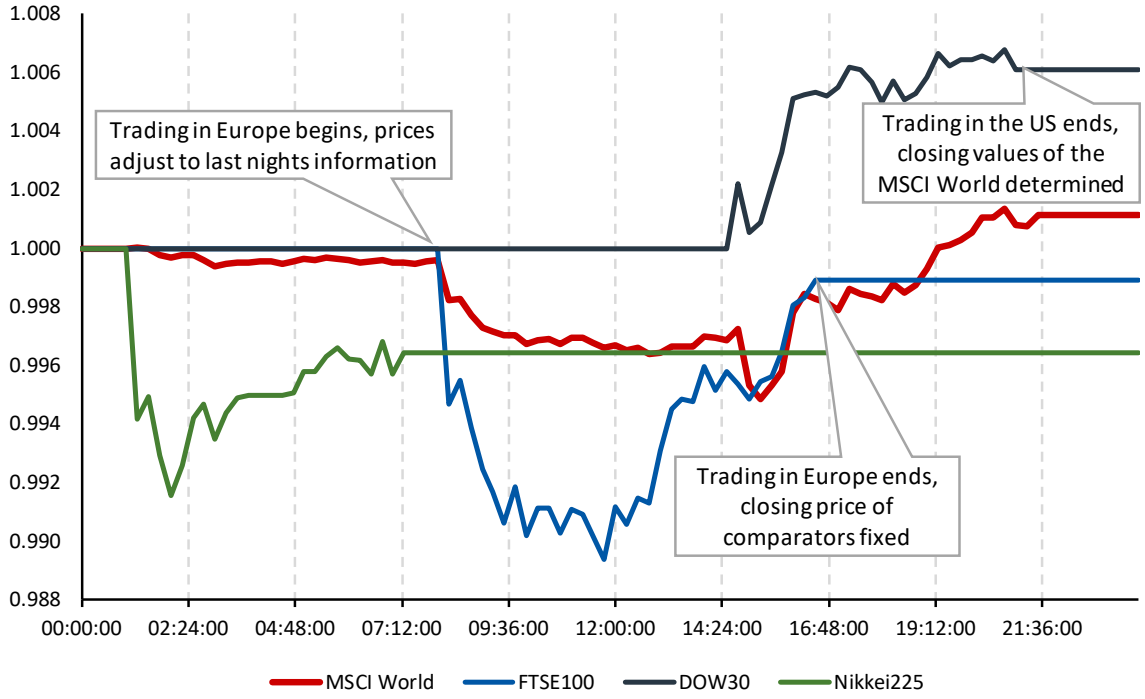
Distortions from Trading Hours

The lower correlation calculated by using the global index may at least partially result from differences in trading hours for the relevant stocks. While the closing prices of European comparators are fixed at the end of the European stock trading (usually around 4:30 pm GMT), the value of the MSCI World is calculated at the end of trading in New York five hours later. This can lead to movements in stock prices and index values which would affect European companies, but which is not reflected in their closing price of that day because the relevant information became available only after the markets closed in Europe.

[64] See index website https://www.msci.com/developed-markets (retrieved 24. January 2020).

[65] See Damodaran (2009): „Equity Risk Premiums (ERP): Determinants, Estimation and Implications – A post-crisis Update", available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1492717 (retrieved: 24 January 2020).

Figure A.1
Trading Hours and Index Values of the MSCI World Index

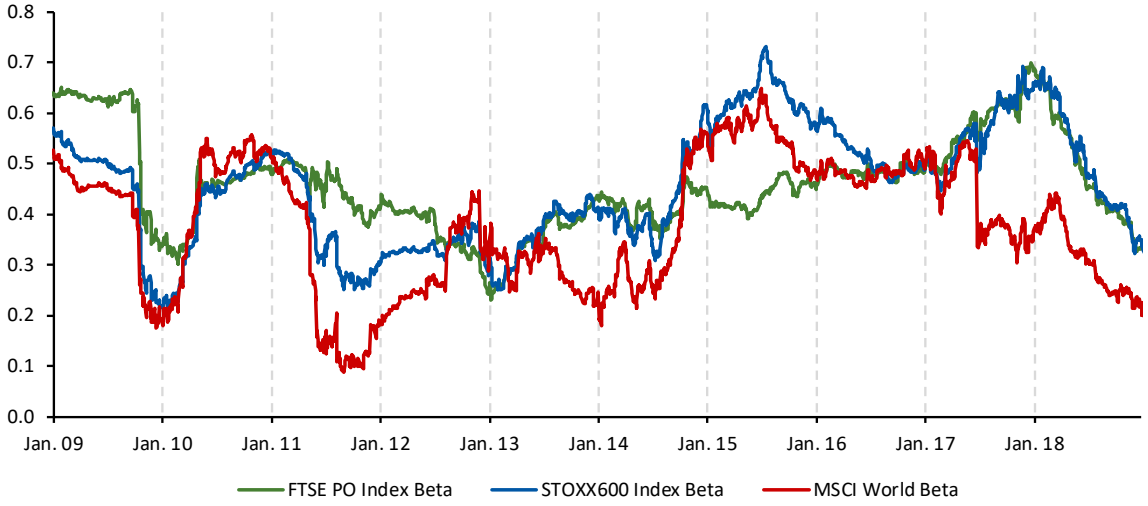


Source: NERA analysis

Figure A.1 shows the issue of differentiated trading hours for a global stock index over one day (25th of September 2019, GMT) using intraday price data. While the Japanese (green) and British (blue) indices open with a fall in prices and close below their opening value, the American index (black) increases over American trading hours and pulls the MSCI (red) above its initial value. The initial losses in Japan and Europe mirror the American losses during the previous afternoon in New York. The gains of the American stock market on the afternoon of the 25th of September, on the other hand, filter through to Asian and European markets on the 26th of September.

By using the MSCI World as reference index, the Ei compares closing prices (and returns) of the European comparators fixed at ca. 4 pm (GMT) with closing prices of the MSCI world fixed at approximately 9 pm (GMT). These closing prices and hence the closing returns do not reflect the same amount of information. Consequently, the measured correlation between these returns (and hence the beta) can be expected to be lower. This, however, does not imply that the actual correlation (and the true beta) is low. Therefore, the use of the MSCI World results in a downward bias of the estimated betas. The Swedish regulator's use of weekly returns to estimate the beta does not cure this bias completely, because new information available on Friday afternoon in New York is not reflected in Asian and European stocks before Monday, and hence the next week.

Figure A.2
One-year Rolling Betas of REN



Source: NERA analysis

Figure A.2 shows the empirical analysis of the described problem. The diagram displays rolling one-year raw beta estimations of the Portuguese TSO REN for the ten-year period considered by Ei. The betas estimated using the MSCI World index as reference are consistently lower than those of the European indices, diverging as much as 75% from the betas obtained by using the national index. Using the FTSE Portugal yields generally more stable estimates. The average of the ten yearly estimates for FTSE PO, STOXX600 and MSCI World are 0.44, 0.47 and 0.37 respectively. The estimated betas reflect the substantially lower correlation of REN's stock price fluctuations with the reference index used by Ei.

Considering the issues of the global stock index such as the MSCI World, using national or European stock indices appears more appropriate. Comparing the returns of network operators to a globally diversified portfolio is not a uniquely Swedish challenge. Nonetheless, no other European regulator relies on a global stock index as reference market. Instead, it is common practice to refer to national stock indices to assess the relative risk of network operators.

Economic arguments and European precedent contest the use of a global reference index. Montell & Partners, Ei's consultant, explicitly recommend using the European STOXX600, too. Yet, Ei appears forced by the ordinance to rely on the MSCI World Index, which illustrates how strict guidelines lead to poor decisions from an economic point of view.

Appendix B. Beta Methodologies

This table provides an overview of the estimation approaches used by the European regulators surveyed for this report and discussed throughout Chapter 3.

Figure B.1
Methodologies used for Beta determination by other European Regulators

Country	Year	Method	Comparators	Reference Market	Period (years)	Frequency	Adjustment
Austria	2018	Empirical estimation	13	National index	3	daily	Vasicek
Belgium (TSO)	2018	Empirical estimation with lower bound	1***	National index	3	daily	Lower bound
Belgium (DSO)**	2016 / 2019**	Empirical estimation**	10 / 9**	National index / Eurozone index**	2 / 5**	daily	Dimson / Blume**
Denmark	2018	Survey of existing studies and European precedent					
Finland	2019	Empirical estimation	14	National index	4	weekly	Ex. estimates with low R^2
France	2016	Empirical estimation & market observations	7	National index	3 & 5	daily	Vasicek
Germany	2016	Weighted empirical estimation	14	National index	1, 3 & 5	daily	Vasicek
Italy	2018	Empirical estimation & evaluation by the regulator	BE, FR, DE, NL	National and European index	2 & 5	daily	Blume
Luxembourg	2016	Weighted empirical estimation	9	National index	1, 3 & 5	daily	Vasicek
Netherlands	2016	Median of estimated comparison betas	8	European index	3	daily	Vasicek
Norway	2019	Empirical estimation	16	National index	5	monthly	*No information*
Portugal	2017	Empirical estimation of regulated activities	2***	National index	3	daily	Blume
Spain	2019	Empirical estimation	29	National index	6	weekly	No
Sweden	2019	Empirical estimation	5	Global Index	10	weekly	No
Switzerland	2019	Empirical estimation	10	*No information*	3	monthly	Tests for signi-ficance (t-test)
United Kingdom	2019*	Empirical estimation & market observations	5***	National index	5-10	daily	No

** Methodology decision of the ongoing consultation process for the RIIO-2 Framework*
*** Flanders (light blue) / Wallonia (dark blue)*
**** Respective national operators are used for estimation*
Source: NERA analysis

Appendix C. Estimation Results

This appendix includes the complete estimation results for each company and each year, which are the basis for the averages and some of the sensitivity analyses discussed in Chapter 5.

Table C.1
Detailed Estimation Results

Company	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average
Terna	0.11	0.22	0.37	0.42	0.28	0.43	0.35	0.38	0.35	0.21	**0.31**
Red Electrica	0.29	0.71	0.47	0.54	0.47	0.52	0.44	0.39	0.38	0.25	**0.45**
Elia	**--**	--	0.18	0.21	0.07	0.37	0.25	0.23	0.34	0.26	**0.24**
REN	0.12	0.17	0.14	0.16	0.11	0.29	0.22	0.20	0.28	0.15	**0.18**
National Grid	0.20	0.30	0.22	0.29	0.43	0.48	0.36	0.46	0.37	0.25	**0.34**
Transelectrica	0.43	0.51	0.48	0.31	0.29	0.65	0.19	0.36	0.56	0.59	**0.44**
Iberdrola	0.59	0.75	0.53	0.59	0.53	0.55	0.46	0.42	0.33	0.27	**0.50**
Endesa	0.56	0.67	0.73	0.83	1.00	0.76	0.54	0.57	0.42	0.37	**0.65**
Average	**0.33**	**0.48**	**0.39**	**0.42**	**0.40**	**0.51**	**0.35**	**0.38**	**0.38**	**0.29**	**0.39**

Source: NERA analysis

Appendix D. Sources

This appendix lists the sources used to assess the beta determination. Appendix D.1 lists the regulatory decisions used in the comparison and Appendix D.2 lists the financial analyst reports.

D.1. Regulatory Decisions

Austria:

- DSO: E-Control (2018): Regulierungssystematik für die vierte Regulierungsperiode der Stromverteilernetzbetreiber 1. Jänner 2019 - 31. Dezember 2023.
- TSO: E-Control (2018): Regulierungssystematik für Stromübertragungsnetzbetreiber 2019.

Belgium:

- DSO (Flanders): VREG (2016): Tariefmethodologie reguleringsperiode 2017-2020: Bijlage 2 Rapport kapitaalkostenvergoeding reguleringsperiode 2017-2020.
- DSO (Wallonia): CWAPE (2017): DECISION CD-17g17-CWaPE-0107 relative à 'la méthodologie tarifaire applicable aux gestionnaires de réseau de distribution d'électricité et de gaz naturel actifs en Région wallonne pour la période régulatoire 2019-2023'.
- DSO (Brussels): Commission de Regulation de l'Energie en Region de Bruxelles-Capitale (2019) Méthodologie 2020-2024 Partie 4 – Electricité.
- TSO: (National) CREG (2018) (Z)1109/10 Arrêté fixant la méthodologie tarifaire pour le réseau de transport d'électricité et pour les réseaux d'électricité ayant une fonction de transport pour la période régulatoire 2020-2023.

Denmark:

- DSO: Energistyrelsen (2018): Bekendtgørelse om forrentningssats for netvirksomheders fremadrettede forrentningsgrundlag.

Finland:

- DSO, TSO: Energiavirasto (2019): WACC-parametrit-2020.xlsx.

France:

- DSO: CRE (2016): Délibération de la Commission de régulation de l'énergie du 17 novembre 2016 portant décision sur les tarifs d'utilisation des réseaux publics d'électricité dans les domaines de tension HTA et BT.
- TSO: CRE (2016): Délibération de la Commission de régulation de l'énergie du 19 octobre 2016 portant projet de décision sur les tarifs d'utilisation des réseaux publics d'électricité dans le domaine de tension HTB.

Germany

- DSO, TSO: BNetzA (2016) BK4-16-160

Italy:

- DSO, TSO: Autorita Energia (2018): Criteri per la determinazione e l'aggiornamento del tasso di remunerazione del capitale investito per i servizi infrastrutturali dei settori elettrico e gas per il period 2016-2021 (TIWACC 2016-2021) – Allegato A.

Luxembourg:

- DSO, TSO: ILR (2016): Règlement E16/12/ILR du 13 avril 2016 fixant les méthodes de détermination des tarifs d'utilisation des réseaux de transport, de distribution et industriels et des services accessoires pour la période de régulation 2017 à 2020 et abrogeant le règlement E12/05/ILR du 22 mars 2012 – Secteur Electricité.

Netherlands:

- DSO, TSO: ACM (2019): Gewijzigd methodebesluiten GTS 2017-2021, kenmerk ACM/UIT/505475, zaaknr ACM/18/033721, Bijlage - Uitwerking van de methode voor de WACC.

Norway:

- DSO, TSO: NVE (2019): Referanserenten, accessible at: https://www.nve.no/reguleringsmyndigheten/okonomisk-regulering-av-nettselskap/om-den-okonomiske-reguleringen/referanserenten/ [accessed 11.02.2020]

Portugal:

- DSO, TSO: ERSE, Parametros de Regulacao Para o Periodo 2018 a 2020.

Spain:

- DSO, TSO: CNMC (2019): Memoria explicativa de la circular de la comisión nacional de los mercados y la competencia, por la que se establece la metodología de cálculo de la tasa de retribución financiera de las actividades de transporte y distribución de energía eléctrica, y regasificación, transporte y distributición de gas natural.

Sweden:

- DSO, TSO: Energiemarknadsinspektionen (2019): Kalkylränta för elnätsföretag för tillsysperioden 2020-2023 – Bilaga 7.

Switzerland:

- DSO, TSO: BFE (2019): Erläuterungen zur Berechnung des kalkulatorischen Zinssatzes gemäss Art. 13 Abs. 3 Bst. b der Stromversorgungsverordnung (StromVV) für das Tarifjahr 2020.

United Kingdom:

- DSO, TSO: OFGEM (2019) RIIO-2 Sector Specific Methodology Decision – Finance.

D.2. Analyst Reports

- Banco de Investimento Global (2019): BiG Company Update – REN, Analyst: Diana Oliveira, 02 April 2019.
- Bank Sabadell (2019): Red Electrica – Less Growth and a Lower Dividend, Analyst: Javier Esteban, 21 February 2019.
- Caixa Bank (2018a): Red Electrica – Fairly priced in current outlook, Analyst: Gonzalo Sanchez-Bordona, 06 February 2018.
- Caixa Bank (2018b): REN – No growth, but superior dividend and value, Analyst: Gonzalo Sanchez-Bordona, 13 June 2018.
- Caixa BI Investment Bank (2018): REN – Stability and a shining dividend, Analyst: Helena Barbosa, 17 July 2018.
- Credit Suisse (2019): Terna – limited growth, demanding valuation, Analyst: Stefano Bezzato, 10 May 2019.
- Deutsche Bank (2019): E.ON – Initiate with Hold: Four key issues, Analyst: James Brand, 08 October 2019.
- Exane BNP Paribas (2018): Elia – Powering the heart of Europe, Analyst: Olivier van Doosselaere, 24 May 2018.
- Exane BNP Paribas (2019a): Red Electrica – uphill battle against sliding earnings, Analyst: Olivier van Doosselaere, 06 November 2019.
- Exane BNP Paribas (2019b): E.ON – Q3 to bring visibility to key items, Analyst: Sofia Savvantidou, 20 November 2019.
- HSBC (2019a): National Grid – Buy: Growth with diversified risks, Analyst: Verity Mitchell, 21 June 2019.

- HSBC (2019b): E.ON – Buy: Multiple short-term distractions, Analyst: Adam Dickens, 12 August 2019.
- HSBC (2019c): E.ON – Buy: Regulated status confirmed; debt not a concern, Analyst: Adam Dickens, 26 September 2019.
- ING (2019): Elia – Growth continues but priced in, Analyst: Quirijn Mulder, 31 January 2019.
- JP Morgan (2019a): REN – Model update – we remain Neutral, Analyst: Javier Garrido, 30 July 2019.
- JP Morgan (2019b): National Grid – Ofgem backs down, Analyst: Christopher Laybutt, 15 October 2019.
- JP Morgan (2019c): Red Electrica – Final CNMC proposal: When you get benefits that do not put you in a better position…, Analyst: Javier Garrido, 31 October 2019.
- JP Morgan (2019d): National Grid – FY20 Interim Result – New York, New York, Analyst: Christopher Laybutt, 14 November 2019.
- KBC Securities (2018): Elia Group – A defensive powerhouse on continued rapid RAB growth, Analyst: Bart Cuypers, 19 September 2018.
- Kepler Cheuvreux (2018): Elia – Two-for-one network exposure, Analyst: Juan Rodriguez, 05 November 2018.
- Macquarie Research (2018): E.ON – They've beat again – 2Q18 above consensus, Analyst: Peter Crampton, 08 August 2018.
- Santander (2019): E.ON – Focused on Leverage and Valuation, Analyst: Oscar Nájar Ríos, 22 October 2019.
- Societe Generale (2019a): Redes Energeticas Nacionais – Approaching a turning point in capex; upgrade to Hold, Analyst: Jorge Alonso Suils, 29 March 2019.
- Societe Generale (2019b): Redes Energeticas Nacionais – Facing lower returns, but there are upside risks: Hold, new TP €2.6, Analyst: Jorge Alonso Suils, 29 July 2019.
- Societe Generale (2019c): Terna – Low financing costs could last longer, Analyst: Bartlomiej Kubicki, 31 July 2019.
- Societe Generale (2019d): National Grid – US rerating helps, UK asset growth is attractive, Analyst: Bartlomiej Kubicki, 12 September 2019.

- Societe Generale (2019e): Italian Regulated Utilities – 9M19 preview – Ongoing growth, Analyst: Bartlomiej Kubicki, 28 October 2019.
- Societe Generale (2019f): Red Electrica – CNMC's new draft regulation improves O&M revenues but raises new doubts, Analyst: Jorge Alonso Suils, 01 November 2019.

Appendix E. About NERA and the Authors

This appendix contains a brief presentation of NERA Economic Consulting, the authors of the report as well as selected previous work in the context of regulatory cost of capital determinations.

E.1. Corporate Profile

NERA Economic Consulting is global firm of economists. providing economic and financial analysis and advice to corporations, governments, law firms, regulatory agencies, trade associations, and international agencies. Our global team of more than 500 professionals operates in over 20 offices across the Americas, Europe, and Asia Pacific, as shown below.

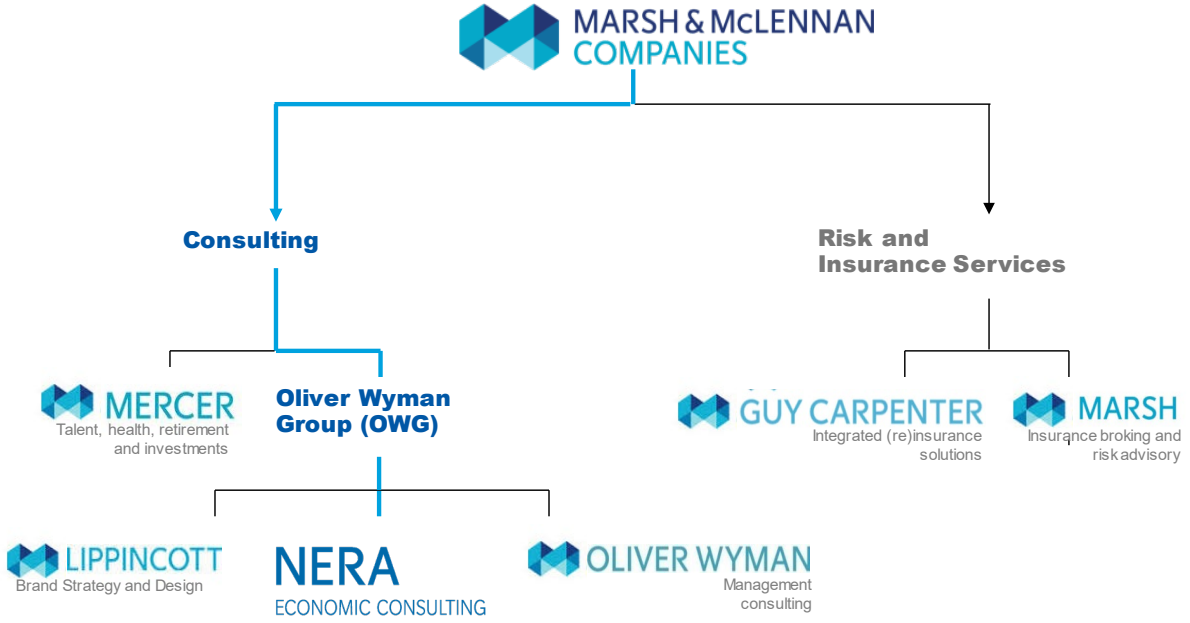
Figure E.1: NERA Offices

Since NERA's foundation in 1961, we have been providing practical economic and financial advice related to highly complex business and legal issues arising from competition, regulation, public policy, strategy, finance, and commercial disputes of all kinds. For over 50 years, we have created strategies, studies, reports, expert testimony, and policy recommendations, reflecting our specialisation in industrial and financial economics. Because of our commitment to deliver unbiased findings, we are widely recognized for our independence.

NERA's Energy Practice specialises in energy and other major infrastructure industries and supports energy networks, industry associations, investors, governments and regulators on energy network regulation, tariff determinations and market design. We also regularly act as due diligence advisors to potential investors on major network sales and investments in the energy space.

NERA is part of Oliver Wyman Consulting Group, the global consulting organization of Marsh & McLennan Companies, Inc. (MMC).

Figure E.2: NERA Organisational Structure



E.2. Authors

We, Tomas Haug and Lorenz Wieshammer, have prepared this report with the support of employees from NERA Economic Consulting GmbH, notably Jakob Lutz. We confirm that we have prepared this report to the best of our knowledge and belief, and with the greatest possible care. We are independent of E.ON Energidistribution AB and their shareholders, as well as their legal advisors. We have no economic or personal interest in the outcome of these proceedings.

Tomas Haug

Tomas Haug is a Managing Director in NERA's Berlin office, were he leads the energy and regulatory team. He has more than 15 years of experience of working in European energy and infrastructure markets. He focuses on regulation, cost of capital, M&A in regulated industries, efficiency benchmarking and tariff design, and supporting clients as expert witness in disputes and litigations.

Tomas Haug has directed and managed numerous advisory projects for regulatory authorities, network operators, and provided regulatory due diligence advice in Germany, Austria, France, Belgium, Czech Republic, the Nordics and the UK, among others. Tomas Haug regularly publishes on regulatory issues. He is the co-author of a book on the cost of capital for electricity and gas networks in Germany. He holds the Chartered Financial Analyst (CFA) designation, a qualification for finance and investment professionals.

Lorenz Wieshammer

Lorenz Wieshammer is a Consultant in NERA's energy and regulatory team in Berlin. He specializes in regulatory und financial economics with a focus on cost of capital estimation. He has published on the regulatory cost of capital in academic journals.

Lorenz Wieshammer holds an MSc in Economics from the London School of Economics. Lorenz Wieshammer is a 2020 CFA level 3 candidate. Prior to joining NERA, Lorenz Wieshammer has worked at the banking supervision department of the German central bank as a research assistant. During his studies, he was a fellow of the German Academic Scholarship Foundation.

E.3. Selected Credentials

- For the Hessian Ministry of Economics (2015): Examination of the airport operator's, Fraport AG, approach for determining the WACC. The work included assessing the consistency of the assumptions as well as a quantification of the beta using various methodological approaches.
- For major German gas and electricity network operators (2016 - 2019): Preparation of expert reports in the context of the appeal procedures at the Higher Regional Court of Düsseldorf and the Federal Supreme Court following the regulator's cost of equity decision for the 3rd regulatory period.
- For the Danish Energy Agency (2016): Advice on various regulatory topics with the aim of improving the regulatory framework of Energinet.dk. The assignment included a general overview of the regulatory regimes of Germany, Britain and the Netherlands as well as an analysis of the approval process for new investments in other regimes.
- For Oesterreichs Energie, the Austrian industry association of energy companies, (2016 - 2019): Support during the consultation phase of the regulatory cost of capital as well as discussion of the proposed methodology at Vienna University of Economics and Business and with the Austrian regulator.
- For Enedis, the operator of the French electricity distribution network, (2017 - 2018): Preparation of expert report in the context of Enedis' appeal against the regulatory beta determination by the French regulatory, the CRE. This case was dealt with at the Conseil d'État.
- For Ofcom, the British telecommunications regulator (2017): Analysis of the appropriate treatment of pension deficits when setting the cost of capital and particularly the beta. The assignment included a review of both the academic and practitioners' literature and analysing advantages and disadvantages of possible adjustment options.

Signature 

Name Tomas Haug
Position Managing Director at NERA Economic Consulting GmbH
Date 25 February 2020
Place Berlin

Signature 

Name Lorenz Wieshammer
Position Consultant at NERA Economic Consulting GmbH
Date 25 February 2020
Place Berlin

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NERA
ECONOMIC CONSULTING

NERA Economic Consulting
Unter den Linden 14
10117 Berlin, Deutschland