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The Challenge of Determining the WACC of Electricity Transmission Service Operators: The Brazilian Case

ABSTRACT

Objective: ANEEL, the Brazilian National Electric Energy Agency, regularly renews its tariff model to remunerate the electricity transmission service operators. This study focuses on the conceded rate of return of the operators' regulatory capital. We aim to contribute to the methodological improvement of the regulator's approach in future tariff reviews by focusing on issues concerning the calculation of this key figure.

Method: We critically review ANEEL's concept of the regulatory rate of return, stressing issues concerning the calculation of this key figure.

Originality/Relevance: We are not aware of any research that analyzes ANEEL's actual model for calculating the regulatory rate of return. In line with ANEEL's search for support, we intend that our considerations will help improve the regulator's approach and serve as stimuli to search for answers to open questions.

Results: We revealed five aspects that give rise to deeper reflections. Our findings suggest that the concept for determining the regulatory rate of return could be adapted to better reflect the Brazilian financial market conditions.

Theoretical/Methodological contributions: As a main finding, the sample of US electric energy companies involved in calculating the so-called ß factor should be reconsidered. Furthermore, to compute the weights of these companies to calculate the sample's unleveraged ß, companies with missing data should be excluded. Moreover, instead of gathering the data for the WACC calculation from quite different periods, these periods should be aligned on a theoretical basis.

Keywords: Regulation; Electricity Transmission Operator; WACC; CAPM; Rate of Return.

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1 INTRODUCTION

The de-verticalization of the Brazilian electricity sector that began in the late 1990s changed the role of the state as the provider of social well-being. It formed the basis for a new sector structure in which necessary investments can stem from private capital. Prior to the new structure, the companies were state-owned and were allowed to undertake the generation, transmission, and distribution of electric energy. With the unbundling of the sector, the companies split up, creating operators that act as energy generators, transmitters, or distributors (ANEEL, 2008).

In the context of the sector's new scenario, the National Electric Energy Agency (ANEEL) was founded in 1997 as the regulatory body of the Brazilian electricity sector. Its purpose is to promote an environment of balance and solid results for its players, while providing low tariffs for the consumers (ANEEL, 2008, p. 18). As the electricity sector is a natural monopoly without competition in the regions granted to each operator, the regulator must simulate such an environment. To this end, it has to be ensured that operators comply with the rules and laws by which they are bound, operating efficiently, offering quality service to consumers and, at the same time, preventing such companies from obtaining excessive profits due to lack of competition in their area (Council of European Energy Regulators [CEER], 2019, p. 108).

The unbundling process in Brazil gave rise to nine energy transmission service operators (TSOs), among others, with long-term concessions. We focus on these TSOs, which were subjected to four tariff review cycles starting in 2007, 2009, 2012, and 2018 (da Silva, Costa, Ahn, & Lopes, 2019). In these tariff reviews, the rate of return is one of the main variables considered, as its determination affects the return on investment and on shareholders' capital (KPMG Corporate Finance, 2019, p. 10). To determine the rate of return, ANEEL uses the weighted average cost of capital (WACC) in combination with the Capital Asset Pricing Model (CAPM) to draw on a standardized method (ANEEL, 2017, p. 2) while observing clear and transparent rules (ANEEL, 2020a, p. 52).

In 2018, ANEEL revoked the pending WACC update of the distribution segment in favor of a methodological review of the WACC in 2019 and included the segments of energy transmission and generation into the discussion (ANEEL, 2020a, p. 7). After the debate on the contributions from the electricity operators and other stakeholders (ANEEL, 2020a, p. 112), the current rules for calculating the TSOs' rate of return came into force on March 18, 2020. They are published in Revision 3.0, sub-module 9.1, of ANEEL's tariff regulation procedures (PRORET). We here refer to these actual rules, which will be applied to update the regulatory rate of return yearly until ANEEL decides to open up again the discussion to adapt them (ANEEL, 2020a, p. 100). However, the public hearing (AP 09/2019) and public consultation (CP 26/2019) conducted beforehand show that there is a lack of consensus on various parameters applied in the WACC and CAPM calculations (see the notes of stakeholders documented in ANEEL, 2020a)[1]. Thus, both the regulatory agency and the TSO group may benefit from academic studies focusing on this subject.

There are already some studies about the regulation of the Brazilian TSO sector, including those of Cassaro, Rego, Parente and Ribeiro (2016), Lopes, de Almeida Vilela, Costa and Cardoso (2018), and da Silva *et al.* (2019). With respect to the CAPM approach, Lanziotti and Garcia (2018) argue that the WACC applied by ANEEL in 2013 was under the real costs of the Brazilian TSO Companhia Estadual de Geração e Transmissão de Energia Elétrica (CEEE). Furthermore, Kayo, Martelanc, Brunaldi and da Silva (2020) propose a way to determine a stable ß factor (this factor is explained in Section 2). Except for their specific considerations, however, we are unaware of any research that analyzes the calculation of the rate of return of regulatory capital published in PRORET 9.1, Revision 3.0.

In line with ANEEL's search for support, our objective is, therefore, to address the regulator's approach to calculating the WACC by suggesting possible improvements in future tariff reviews. Our suggestions can be outlined as follows:

1. The sample of US electric energy companies involved in calculating the so-called ß factor should be reconsidered, as the sample does not reflect the situation of the Brazilian energy transmission market.
2. One of ANEEL's directives is simplicity of calculation (ANEEL, 2020a, p. 62 and 108). As the regulator's six-step procedure to calculate the ß factor violates this directive, the regulator should consider options for simplification.
3. When computing the weights of the US companies to calculate the sample's unleveraged ß, the companies with missing data should be excluded.
4. Instead of gathering the data for the WACC calculation from quite different periods, it seems reasonable to align these periods on a theoretical basis. When deciding which of the available data from the chosen period(s) to use, the goal should be to avoid potential calendar anomalies.
5. As changing market conditions and the management of equity and debt are interconnected, we suggest calculating the costs of equity and debt based on data stemming from the same period.

The rest of the paper is organized as follows: In Section 2, the basic concept for calculating the rate of return based on WACC and CAPM is depicted. Section 3 focuses on how ANEEL implemented this concept, and addresses the critical issues outlined above. Resulting conclusions are presented in Section 4.

2 BASIC CONCEPT FOR CALCULATING THE RATE OF RETURN

Fundraising for electricity sector investments competes with other investment opportunities available to investors. From their perspective, the rate of return on investment must be attractive and consistent with the risk incurred to maximize its expected return. At the same time, it is of fundamental importance that the consumers' concerns, mainly low energy prices and a stable system, are also taken into account. Establishing a decent balance between these interests is a major challenge for ANEEL, since the Brazilian electricity sector will demand investments of approximately USD 111 billion[2] until 2029 (Campos, 2019).

Despite operating in a sector of natural monopolies, TSOs should obtain a return on capital like in a sector of free competition in order to not overburden the consumers (CEER, p. 114). On the other hand, the return obtained must be sufficient to remunerate the TSOs for the capital invested and to allow them to provide a high quality of service (KPMG Corporate Finance, 2019, p. 10). ANEEL's role as the regulator is to make the balance between the investment return and the tariff charged to the consumers viable. For this purpose, ANEEL seeks to apply mathematical methods with explicit variables, reducing the adoption of choices and its subjectivity (ANEEL, 2005). Concerning the regulatory rate of return, ANEEL (2020a, p. 15) states that most agents consider applying the WACC in combination with CAPM to be appropriate.

The WACC measures the average cost of capital according to the share of equity and debt. It denominates with which minimum rate of return one company must remunerate its financing sources based on the risk of the investment made (Brealey, Myers, & Marcus, 2001, p. 443), according to

$$\mathrm{WACC} = ((E/(E+D)) \cdot r_e) + ((D/(E+d)) \cdot r_d \cdot (1 - T)), \tag{1}$$

where E = equity, r_e = cost of equity, D = debt, r_d= cost of debt and T = tax rate.

Determining the cost of equity used to calculate the WACC commonly draws on the CAPM, a model attributed to Lintner (1965), Mossin (1966) and Sharpe (1964). These authors proposed a model of equilibrium in the price of risky assets based on the portfolio theory (Markowitz, 1952), where the expected return of a risky asset i is equivalent to the risk-free rate plus a risk premium depending on the risk incurred. The respective CAPM formula is

$$E(R_i) = Rf + \beta \cdot (R_m - Rf), \quad (2)$$

where Rf = risk-free rate, R_m= market return, $\beta \cdot (R_m - Rf)$ = market risk premium and $E(R_i)$ = expect return of company i. In this way, the risk premium is obtained by subtracting the return of the risk-free asset from the rate of return from the market ($R_m - Rf$) multiplied by the β factor, which is defined as

$$\beta_i = COV_{i,market} / \sigma^2_{market}, \quad (3)$$

β_i is a measure for the sensitivity or volatility of an asset i (or portfolio) in relation to the market, with σ^2_{market} = market variance and $COV_{i,market}$ = covariance of asset i and the market.

The CAPM model is subject to criticism because it considers assumptions that are not part of the reality experienced in the financial market, such as: (i) investors can obtain loans or lend resources at the same rate without limits; (ii) only one variable, β, explains all the sensitivity of the asset in relation to the market; (iii) inability to measure the market rate of return of the total assets in the market, among others. However, Sharpe (1964, p. 434) considers that despite being a theoretical model, what matters is the acceptability of its implications.

3 CRITICAL ISSUES CONCERNING ANEEL's WACC APPROACH

The following considerations refer to Revision 3.0, sub-module 9.1, of ANEEL's tariff regulation procedures (PRORET). Figure 1 shows the respective variables in determining the WACC. It depicts how ANEEL adapts the basic concept for calculating the rate of return described in Section 2 to reflect market conditions while balancing the expected return on investments and the tariff burden to the consumer. However, the regulator's approach raises some questions, which are discussed in the following (note that ANEEL is aware of the challenges of its approach; see ANEEL, 2020a, p. 111).

3.1 Sample of US electric energy companies: Status quo and discussion

To determine the ß factor, ANEEL draws on a sample of US companies that are members of the Edison Electric Institute (EEI). This institute represents all US investor-owned electric energy companies, which provide electricity for about two-thirds of USA's population (EEI, 2020a). ANEEL uses data from 21 of these companies, which are part of the sample for at least one year from 2013 to 2019.

In ANEEL's public hearing 15/2018, the Brazilian TSO Companhia de Transmissão de Energia Elétrica Paulista (CTEEP), among others, criticized the proposed sample. The company suggested the derivation of the ß factor from the Brazilian market using data from companies listed in the São Paulo Stock Exchange Electricity Index to better represent the Brazilian companies' risk (ANEEL, 2020a, p. 28). Also, the Brazilian Association of Electricity Distributors (ABRADEE), the Equatorial Energia Group and the already mentioned TSO CEEE questioned the sample, suggesting the adoption of a global β. Both alternatives were not accepted by the regulator (ANEEL, 2020c, p. 28).

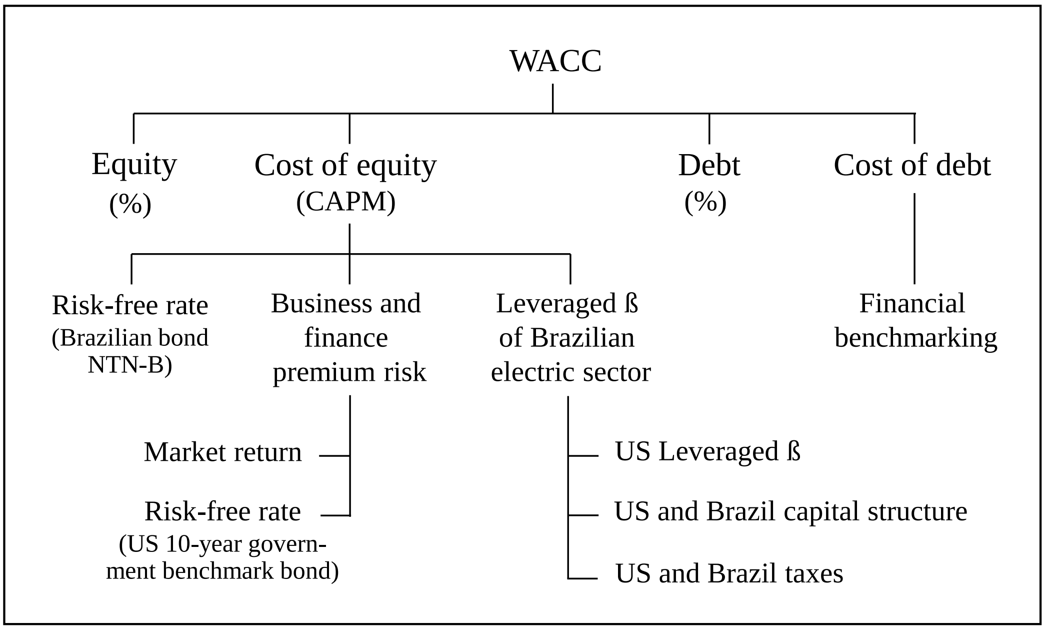

Figure 1. ANEEL's WACC components

Instead, ANEEL unleverages the ß of the sample of the US companies to exclude their financial risk, then releverages the factor by considering the regulatory capital structure of Brazilian companies (Section 3.2 describes the process in detail). In addition, a risk premium according to formula (2) is added. However, as Hilscher and Wilson (2017, p. 1) point out, the result may not reflect the probability of default and the systematic risk perceived by an investor. We provide below three aspects that should be considered.

First, there are considerable differences between US and Brazilian companies concerning their risk. One measure of risk is the credit risk rating, which represents a universal benchmark regarding a company's reliability and ability to honor its debt in the long term (Standard & Poor's Global Ratings, 2020). Banks, creditors, regulators, pension fund trusts and others use such ratings, e.g., Standard & Poor's Global Ratings, as a means of parameterizing investments and limiting excessive risk-taking (Cantor, Ap Gwilym, & Thomas, 2007, p. 13). In this way, investors can compare the return-risk structure of their actual investment portfolio with that of other portfolios.

Ratings referring to a global scale allow for comparing companies from different countries based on their credit risk (Standard & Poor's Ratings Services, 2013). The respective ratings on December 31, 2019, of the US companies used in ANEEL's sample are shown in the left chart of Figure 2. 77% of the companies achieved an investment grade level (comprising ratings from "A–" down to "BBB") (EEI, 2020b). As the chart on the right side of the figure depicts, the Brazilian situation at the end of 2019 was quite different: With ratings from "BB stable" down to "B positive" and four companies not rated, none of the nine TSOs exhibited an investment grade level (Eikon, 2020). Therefore, the company sample used by the regulator to derive data for the Brazilian TSOs' WACC calculation is questionable.

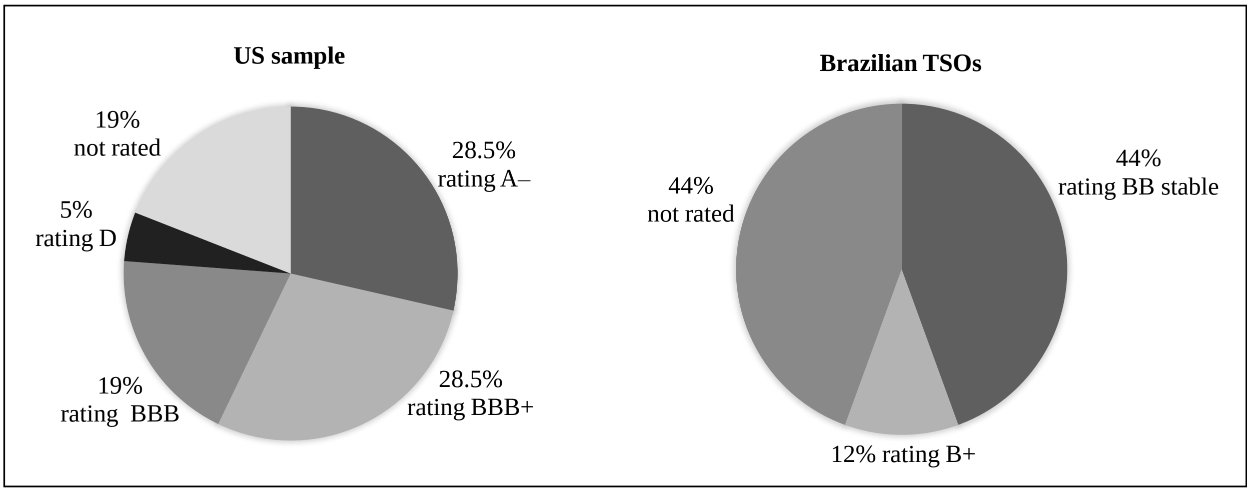

Figure 2. Different rating structures: ANEEL's sample companies versus the Brazilian TSOs

As a second aspect, the data source is embedded not only in a better risk environment, but also in a better environment of access to capital. It is important to take the level of efficiency of the US stock market into account, which, as stated by ANEEL (2020a, p. 18), is considered the largest in the world. In June 2018, the total market value of companies listed on the New York Stock Exchange was USD 28.53 trillion while the total market value of companies listed on the São Paulo Stock Exchange was only around USD 1 trillion (Intercontinental Exchange, 2020; Monteiro, 2019).

In contrast to the respective conditions to meet capital demand, the Brazilian energy sector experiences a much more dynamic development than the US energy sector. From 2000 to 2018, the consumption of electric energy in Brazil grew by 2.6% per year, while the growth in the USA was 0.6% per year. In the same period, electricity production grew by 3% per year in Brazil, while in the USA, there was a growth of 0.5% per year (Enerdata, 2020). To meet the rapidly increasing energy demand in Brazil, outstanding investments are necessary, which only materialize if there is a satisfactory rate of return on investments (Campos, 2019). However, ANEEL's approach does not explicitly consider the discrepancies between the capital market and energy sector conditions.

A third aspect refers to the issue of dividend payment. Myers and Majluf (1984) conclude through Pecking Order Theory that in environments where information asymmetry occurs, companies should finance new projects in this order: (i) dividend retention, (ii) issuance of debts and (iii) capital increase. The importance of dividends for corporate finance is observed in the context in which dividends can affect a firm's capital structure (Futema, Basso, & Kayo, 2009, p. 44). However, the Brazilian rules for dividend payment differ significantly from those in the USA.

In Brazil, shareholders can be remunerated through dividends (Law 6.404, 1976, art. 202) and interest on equity (JSCP – juros sobre o capital próprio; see Law 9.249, 1995, art. 9). While dividends stem from profit, JSCP is calculated based on the shareholders' equity and classified as a financial expense, providing tax benefits for the company. As Pereira (2011) states, shareholders receive JSCP as a compensation for the unavailability of the resources invested in the company. While individuals have to pay 15% taxes on JSCP, dividends are not included in the tax base of private persons in Brazil (Law 9.249, 1995, art. 10), contrary to the rules in the USA. Hence, "the theory that dividends are bad because they induce income taxation (...) does not currently have practical applications in Brazil" (translated from Portuguese) (Assaf Neto, & Lima, 2011, p. 622).

Furthermore, Brazilian companies are obliged to determine the minimum dividend rate in advance and are bound to this statement. This commitment places a great burden on the companies, since “it does not matter if the profit is formed with or without the consequent cash availability” (translated from Portuguese) (Assaf Neto, 2007, p. 499). In other words: The obligation to pay the announced dividend rate has negatively impacts the capital available for new investments necessary for the expansion and modernization of the Brazilian electricity sector. ANEEL does not explicitly address this unique market condition. This unique market condition is not explicitly addressed by ANEEL.

3.2 Procedure to calculate the regulatory ß factor: Status quo and discussion

ANEEL (2019) derives the ß factor in six steps:

1. The leverage ß is calculated, from Oct. year_(t-4) to Sep. year t, for the sample of US companies described above provided that the sum of transmission and distribution assets comprised at least 50% of the total assets.
2. The resulting leveraged ß of each company in each year is unleveraged, using the mean leverage level of each company of the last five years (from Oct. year_(t-1) to Sep. year t) and a US tax rate T_{US} of 39.30%, as

$$Bu_{i,t} = (Bl_{i,t} * (1 - \textstyle\sum_{n=t}^{t-4}((D/(D+E))_{i,n}/5)))/(1 - ((\textstyle\sum_{n=t}^{t-4}(D/(D+E)_{i,n})/5) * T_{US})), \tag{4}$$

   with $Bu_{i,t}$ = company i unleveraged ß factor in time t; $Bl_{i,t}$ = company i leveraged ß factor in time t; D = debt; E = equity; $\sum_{n=t}^{t-4}(D/(D+E))_{i,n}/5$ = company i mean leverage for the last five years.
3. Each unleveraged ß is weighted considering the ratio of transmission plus distribution assets to total assets.
4. The weighted mean of all companies’ unleveraged ß factor s for each year are calculated. The results represent the “US sector unleveraged ß factor” for each following year.
5. The US sector unleveraged ß factor” for each year is releveraged, using the capital structure determined by the regulator and a Brazilian tax rate T_{BR} of 34%, as

$$Bl_{BR,t} = (Bu_{US,t} * (1 - (D/(D+E)_t) * T_{BR})/(1 - (D/(D+E)_t), \tag{5}$$

   with $Bl_{BR,t}$ = Brazilian sector leveraged ß factor in time t; $Bu_{US,t}$ = US sector unleveraged ß factor in time t; D = debt; E = equity; $(D/(D+E))_t$= capital structure determined by the regulator in time t.
6. The “regulatory ß factor of year t” – in other words, the ß factor that will be used to calculate the regulatory WACC of year t – is calculated as the mean of the Brazilian sector leveraged ß for the last five years. For example, the Regulatory ß factor of 2020 is the mean of the Brazilian sector leveraged ß of 2015 to 2019. It is used to calculate the regulatory WACC 2020, e.g., the “Regulatory Rate of Return of Capital of the year 2020”. This is the rate of return allowed for the TSOs’ investments.

As the procedure is complicated, the question of whether it has been seriously scrutinized arises. Concerning the overall approach, although ANEEL states that it is necessary to completely reevaluate the methodology used to calculate the WACC (ANEEL, 2020a, p. 23), the replacement of WACC and CAPM by another methodology had initially been discarded (ANEEL, 2020a, p. 17). Concerning single parameters, ANEEL’s directive is “regulatory stability” (ANEEL, 2020a, p. 108): if two alternative variables have both strengths and weaknesses, the one that deviates less from the hitherto applied variable has to be chosen. In the light of these two arguments, it does not seem likely that ANEEL managed to profoundly reevaluate the applied procedure.

However, there are some arguments for the need for such a reevaluation. First, ANEEL's directive of simplicity of calculation is to mention (ANEEL, 2020a, p. 62 and 108). Especially, the depicted procedure for the ß factor calculation as part of the puzzling overall methodology appears to possess potential for simplification. In this context, the issue already discussed in Section 3.1 could also be addressed: the determination of the ß factor draws on a sample of US companies, with private information taken from Bloomberg LP concerning the return of the companies, the S&P 500 market index and market return (ANEEL, 2020a, p. 120). Another source of data, along with a simplification of the procedure to calculate ß, could eventually better account for two further directives (ANEEL 2020a, p. 108): to use "local data, if possible", and "public data, if possible" (translated from Portuguese).

3.3 Weights of the US sample companies: Status quo and discussion

It is possible to reconstruct the determination of the US unleveraged ß using an online spreadsheet (ANEEL, 2019). This spreadsheet presents results that coincide with the ones in the printed version of the tariff regulation procedures PRORET 9.1, Revision 3.0. One step of the respective procedure of data processing is questionable, as explained in the following.

To build the US energy company sample, ANEEL considers those EEI members whose sum of transmission and distribution assets in the respective year amounts to at least 50% of the total assets. For 2012, e.g., nine companies fulfill this criterion. To account for the relative importance of these companies, ANEEL assigns a weight to them based on the respective ratios of transmission plus distribution assets to total assets (see Section 3.2, step 3 of the procedure to calculate the regulatory ß factor). By normalizing these ration to the interval (0,1), the companies' weights are determined. The US sector unleveraged ß factor (for the following year) is then derived by building the weighted mean of the companies' individual ß factors (see Section 3.2, step 4 of ANEEL's procedure).

When trying to comprehend the regulator's procedure and respective results, it became apparent that two companies with missing data are included in the weight determination. Specifically, the individual ß factor of the CH Energy Group for the year 2012 and that of Pepco Holdings Inc. for the year 2015 are missing. Without these data, however, the companies should be excluded when computing the sample's unleveraged ß. This will change the weights of the remaining companies and finally affect the calculation of the US sector unleveraged ß factor for the respective following years 2013 and 2016, as Figure 3 shows.

ANEEL´s results

US unleveraged ß						
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
0.3862	0.3889	0.3338	0.2937	0.3102	0.2574	0.2487

Proposed correction

US unleveraged ß						
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
0.4340	0.3889	0.3338	0.3269	0.3102	0.2574	0.2487

Figure 3. Effect of the corrected weighting on the US unleveraged ß

While the effect of such a correction can generally result in higher or smaller numbers, it can be seen that the US unleveraged ß will rise here in both cases. This tendency remains in the next steps of the procedure to determine the regulatory ß factor: First, the US unleveraged ß is used to calculate the Brazilian sector leveraged ß factor of each year (see Section 3.2, step 5 of the procedure). Second, the regulatory WACC is calculated as the average of the five previous years of the Brazilian sector leveraged ß factor (see Section 3.2, step 6 of the procedure). For the regulatory years 2018–2020, Figure 4 illustrates the WACC as computed by ANEEL versus the WACC resulting from the weight correction.

ANEEL's results

Regulatory WACC components	2018	2019	2020
Cost of equity			
Risk free rate	6.40%	6.12%	5.83%
Leveraged β	0.5190	0.4727	0.4223
Market risk premium	6.38%	6.43%	6.46%
Financial and business risk premium	3.31%	3.04%	2.73%
Real return post–tax	9.71%	9.16%	8.56%
Cost of debt			
Bonds	6.92%	6.72%	6.31%
Bonds cost of issuing	0.35%	0.40%	0.37%
Real return pre–tax	7.27%	7.12%	6.68%
Tax rate	34.00%	34.00%	34.00%
Real return post–tax	4.80%	4.70%	4.41%
Capital structure			
Equity (%)	58.27%	60.37%	61.86%
Debt (%)	41.73%	39.63%	38.14%
WACC			
Real, pre–tax	11.61%	11.20%	10.57%
Real, post–tax	7.66%	7.39%	6.98%

Proposed correction

Regulatory WACC components	2018	2019	2020
Cost of equity			
Risk free rate	6.40%	6.12%	5.83%
Leveraged β	0.5436	0.4825	0.4321
Market risk premium	6.38%	6.43%	6.46%
Financial and business risk premium	3.47%	3.10%	2.79%
Real return post–tax	9.87%	9.22%	8.62%
Cost of debt			
Bonds	6.92%	6.72%	6.31%
Bonds cost of issuing	0.35%	0.40%	0.37%
Real return pre–tax	7.27%	7.12%	6.68%
Tax rate	34.00%	34.00%	34.00%
Real return post–tax	4.80%	4.70%	4.41%
Capital structure			
Equity (%)	58.27%	60.37%	61.86%
Debt (%)	41.73%	39.63%	38.14%
WACC			
Real, pre–tax	11.75%	11.26%	10.63%
Real, post–tax	7.75%	7.43%	7.02%

Figure 4. Effect of the corrected US unleveraged ß on the Brazilian regulatory WACC

Provided that our suggestion for correction is approved, the remuneration of the TSOs should be based on a post-tax WACC that is 0.09% higher for the regulatory year 2018 and 0.04% higher for the regulatory years 2019 and 2020. A respective adjustment may be significant from the point of view of the TSOs. A recent study postulates that a reduction of the regulatory WACC of 1% reduces 25% of the investments in the electric sector, amounting to around one billion U.S. dollars, considering the exchange rate of December 31, 2019 (Centro de Estudos em Regulação e Infraestrutura da Fundação Getúlio Vargas, & Neoenergia, 2019, p. 7).

3.4 Time-related aspects of data collection: Status quo and discussion

In the context of gathering the information for the WACC calculation, it has to be decided from which period data are collected, which of the available data of this period are used and how they are aggregated, e.g., which central tendency measure is chosen. Table 1 summarizes the regulator's respective decisions, which are quite different for the particular variables.

If data of a short period is used, the WACC calculated for each regulatory year will be very volatile, whereas for a long period, the WACC will be very stable. Hence, it is necessary to find a compromise between the two extremes, providing a certain level of predictability of the WACC, while at the same time reasonably capturing the market changes concerning risk, interests etc. Specifically, the period adopted to obtain the data should reflect (only) those developments that have an actual impact on the financial markets, e.g., political and financial booms or crises, wars and pandemics. As such developments affect all central variables in calculating the WACC, it is evident that the chosen period should be applied equally to the variables.

Table 1
Time-related aspects of the regulatory data

Parameters	Chosen data and measure of central tendency	Period
1) % of equity	% of equity = equity/(equity + debt)	n–1
2) Cost of equity (CAPM)	Mean on a yearly basis	n–1 to n–5
2.1 Risk free rate + country risk	Mean on a daily basis	n–1 to n–10
2.2 Market risk premium	Mean on a monthly basis (last day of the month)	Since Dec. 1928 until Sep. present year
2.3 Sector leveraged β – Brazil	Weighted average of companies unleveraged β	n–1
2.3.1 Companies leveraged β	Mean of the last five years on ...	n–1 to n–5
2.3.1.1 Return of EEI companies shares	... a weekly basis (Fridays)	n–1 to n–5
2.3.1.2 S&P 500 index	... a weekly basis (Fridays)	n–1 to n–5
2.3.2 Companies unleveraged β	Leveraged β of each company for each year, while the debt ratio is considered a mean of the last five years	n–1
2.3.2.1 Debt ratio to unleveraged β	Mean of the last five years	Sep. n–1 to Dec. n–6
2.3.2.2 Debt ratio	Mean of each year and then mean of the last five years on ...	Sep. n–1 to Dec. n–6
2.3.2.2.1 Market capitalization	... a quaterly basis	Sep. n–1 to Dec. n–6
2.3.2.2.2 Debt	... a quaterly basis	Sep. n–1 to Dec. n–6
3) % of debt	% of debt = debt/(equity + debt)	n–1
4) Cost of debt	Certificate of Interbank Deposit or mean return of TSO's corporate bonds indexed by inflation	n–1 to n–10

Source: Based on information from ANEEL (2020a; 2020b).

In contrast, ANEEL uses very different periods, as Table 1 shows. For example, an average of the capital structure of the last five years builds the basis to deleverage the US sectoral ß factor (item 2.3.2), while last year's data build the basis to leverage it with the capital structure of Brazilian companies. It is worth emphasizing that the period from December 1928 to September of the particular year is considered for calculating the market risk premium (item 2.2). Thus, there is no recognizable concept concerning the determination of the applied periods, which raises the question of the intention behind the different periods.

A second concern pertains to selecting specific reference dates within the determined periods to create the database. The literature states that data may be distorted depending on certain reference dates, causing calendar anomalies. Calendar anomalies are a group of financial market phenomena related to certain reference dates that are inconsistent with financial market theory. Rossi (2015), e.g., provides an overview of such anomalies. Three of them are important in our context: (i) the "turn-of-the-year effect", also known as "January effect", first reported by Rozeff and Kinney (1976), who found evidence that yearly differences in monthly mean returns are influenced by the returns observed in January; (ii) the "turn-of-the-month effect", observed as a rise in stock prices in the last five days of the month and the first four days of the next month (Ariel, 1987; Lakonishok, & Smidt, 1988; van der Sar, 2003); (iii) the "day-of-the-week effect", describing that abnormal mean returns are higher on Fridays than on other days of the week (Chiah, & Zhong, 2019; Zhang, Lai, & Lin, 2017; Osborne, 1962).

Despite being aware of the possible effects of such calendar anomalies, ANEEL (2020a, p. 76) does not consider this topic relevant when stating that it "... is not an insurmountable problem, as there are countless other effects already identified in the literature in relation to CAPM" (translated from Portuguese). In contrast, some companies and associations questioned ANEEL during the public consultation 26/2019 about the use of the weekly return of US companies to calculate the ß factor instead of daily data (ANEEL, 2020a, p. 71). Contrary to ANEEL's position, the concerns are plausible: as the weekly data refer to Fridays, they may be indeed subject to the "day-of-the-week effect". In addition, ANEEL calculates the market risk premium through the monthly return of the S&P 500 index using data of the last day of the month. These data could be influenced by the "turn-of-the-month effect", "turn-of-the-year effect", and the "day-of-the-week effect". If such effects really occur in the context discussed here, remains to be investigated. Meanwhile, there is no apparent impediment to using daily data to avoid possible calendar anomalies.

3.5 Cost of equity calculation: Status quo and discussion

ANEEL determines the cost of equity using the CAPM. Since this model is based on a set of assumptions not observable in the real world, some adjustments may be necessary to better reflect the economic reality and the local corporate environment. It is advisable that there is a theoretical basis that justifies such adjustments, as it will be expected that the regulator minimizes subjective choices to address the existing problems without the interference of personal beliefs.

However, when analyzing the regulator's methodology for determining the rate of return, some inconsistency can be observed: For the calculation of the cost of equity, ANEEL (2020a, p. 104) uses the average of the cost of equity of the five years (t–4,…,t) prior to the application period, creating its own concept of "regulatory capital shielding". The other data, e.g., the cost of debt, tax rate and capital structure, originate only from the previous year. Hence, formula (1) is partially adapted as follows:

$$r_{WACC} = ((E/(E+D)) * (\sum_{n=t}^{t-4} r_{e_n}/5) + ((D/(E+D)) * r_d * (1-T))), \tag{6}$$

$$r_{WACC^{pre}} = r_{WACC} / (1-T),$$

where r_{WACC} = WACC, $r_{WACC^{pre}}$ = WACC before taxes, r_e = cost of equity, r_d = cost of debt, E = equity, D = debt and T = tax rate.

For example, the cost of equity to be applied in the year 2020 is the average cost of equity for 2015–2019, while the cost of debt to be applied in 2020 is derived from the 2019 data. ANEEL (2020a, p. 104) justifies this concept by stating that "... equity capital is more rigid in nature than debts" and that a TSO "… can modify the profile of its debts to benefit from better terms, which is not so easy with equity capital, if not impossible" (translated from Portuguese). This justification is questionable. As a first argument, the addressed case of benefiting from better terms for debts is a special case. Market conditions for new loans could also get worse, so that companies have no option to restructure their debts beneficially. If they are even forced to refinance expiring loans with more unfavorable ones, applying an average cost of debt measure could be appropriate to smoothen the effect.

A second argument for calculating both the cost of equity and the cost of debt as an average of a certain period is that equity and debt are interconnected. Especially, supposing the financial market has some liquidity, at least those TSOs listed on the stock exchange may take advantage and raise their equity capital, automatically reducing the debt share. This share is further reduced if the TSOs succeed in using the additional equity capital to replace unfavorable loans. Although the resulting positive effect appears on the cost of debts, it has to be attributed to the decision on the equity increase. In this case, ANEEL's concept of regulatory capital shielding creates a mismatch regarding the smoothened (rise of the) cost of equity capital and the not-smoothened (reduction of the) cost of debts.

4 CONCLUSIONS

The paper addresses how the Brazilian regulatory agency ANEEL determines the rate of return based on the WACC and CAPM to remunerate the nine Brazilian TSOs with long-term concessions. The last respective tariff review cycle started in 2018, resulting in the current rules for calculating the TSOs' regulatory rate of return, which came into force on March 18, 2020. Earlier, these rules were subject to public contributions concerning possible adaptations, revealing a lack of consensus on various parameters applied in the WACC and CAPM. Against this background, we analyzed ANEEL's approach and found five aspects that give rise to deeper reflections:

1. We suggest reconsidering the sample of US electric energy companies involved to calculate the ß factor. Compared to this sample, the international credit risk ratings of the Brazilian TSOs and their access to capital are significantly worse. However, the need for investments in the electric energy sector of Brazil is considerably higher than in the USA. At the same time, Brazilian companies are bound to pay a minimum dividend rate determined by them in advance. Hence, the US company sample seems not to reflect the situation of the Brazilian TSOs. One option could be to compose a sample of electricity companies from developing countries, as suggested, e.g., by the Brazilian Association of Electricity Transmission Companies (ABRATE) during the public hearing 15/2018 (ANEEL, 2020c, p. 28). In this case, instead of the S&P 500 index used by ANEEL as a proxy for the market return to calculate the ß factor (ANEEL 2020c, p. 18), it would be more appropriate to use the MSCI ACWI Index, which represents the performance of stocks across developed and emerging markets (MSCI Inc., 2021).

2. One of ANEEL's main directives regarding the regulation model is simplicity of calculation. We believe that the regulator's six-step procedure to calculate the ß factor needs to account more for this directive. Options for simplification may especially arise in the context of exchanging the US company sample for a more appropriate one.

3. The regulator derives the US sector unleveraged ß factor by applying a weighted mean of the companies' individual ß factor. In two cases, companies are included in the weight determination although their ß factors data are missing. In our opinion, these companies should be excluded to calculate the sample's unleveraged ß. While the effect of such a correction is generally undetermined, the regulatory pre-tax WACC will increase in the present case by 0.09% for 2018 and 0.04% for the years 2019 and 2020.

4. The data for the WACC calculation are collected from quite different periods, ranging from one year to nearly a century. This could be aligned to a certain extent based on deeper deliberations upon the market effects that the data should (not) reflect. In addition, the decision about which of the available data from the chosen period(s) are used is important in order to avoid potential calendar anomalies.

5. While the cost of equity is calculated by building an average of five years prior to the application period, the other data, especially the cost of debt, originate only from the previous year. However, because of the interconnection of changing market conditions and

equity as well as debt management, we suggest calculating their costs based on an average of data stemming from a certain period.

In line with ANEEL's search for support (ANEEL 2020a, p. 23), our intention is that our considerations will help to improve the regulatory rate of return and serve as stimuli to search for answers to the open questions. There is a need to investigate, e.g., which peer group is the best to replace the US company sample. As a second example, it may be interesting to analyze if calendar anomalies can be found with respect to the data applied. The resulting individual possibilities for enhancement could finally be merged into a quantitative study to simulate their joint effect on an adjusted calculatory rate of return. Beyond this, a challenging field for further research is the analysis of the effects of the Covid-19 pandemic with respect to the WACC.

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NOTES

1 - Public hearings and consultations are ways in which ANEEL interacts with the society. In a public consultation, the regulator proposes ideas for consideration and receives contributions of the electricity operators and other stakeholders in the form of documents. In a public hearing, the regulator receives oral contributions (Law 13.848, 2019).

2 - Original values expressed in BRL (Brazilian Reais) converted to USD using the exchange rate of December 31, 2019: 1USD = 4.0307 BRL (Banco Central do Brasil, 2021).

O Desafio para Determinar o WACC das Operadoras de Transmissão de Eletricidade: O Caso Brasileiro

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RESUMO

Objetivo: A ANEEL, Agência Nacional de Energia Elétrica, regularmente renova seu modelo tarifário para remunerar as operadoras de serviços de transmissão de energia elétrica. Como um componente da abordagem atual, estamos nos concentrando na taxa de retorno regulatória concedida às operadoras. Ao enfatizar as questões relativas ao cálculo deste índice, pretendemos contribuir para a melhoria metodológica da abordagem do regulador em futuras revisões tarifárias.

Método: Revisamos criticamente o conceito da ANEEL de taxa de retorno regulatória, destacando questões relativas ao cálculo deste índice.

Originalidade/Relevância: Não temos conhecimento de nenhuma pesquisa que analise o modelo atual da ANEEL para cálculo da taxa regulatória de retorno. Em linha com a busca da ANEEL por respaldo, nossa intenção é que nossas considerações ajudem a aprimorar a abordagem do regulador e sirvam de estímulo para a busca de respostas às questões em aberto.

Resultados: Encontramos cinco aspectos que suscitam reflexões mais profundas. Nossas considerações sugerem que o conceito de determinação da taxa regulatória de retorno poderia ser adaptado para melhor refletir as condições do mercado financeiro brasileiro.

Contribuições teóricas/metodológicas: Como principal achado, deve-se reconsiderar a amostra de empresas norte-americanas de energia elétrica envolvidas no cálculo do chamado fator ß. Além disso, para calcular os pesos dessas empresas para incorporar ao cálculo do ß desalavancado da amostra, as empresas com dados ausentes devem ser excluídas. Também foi observado que, em vez de reunir os dados para o cálculo do WACC de períodos bastante diferentes, esses períodos devem ser alinhados a uma base teórica.

Palavras-chave: Regulação; Operador de Transmissão de Eletricidade; WACC; CAPM; Taxa de Retorno.

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