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Profitability Determinants of Unlisted Renewable Energy Companies in Germany—A Longitudinal Analysis of Financial Accounts

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Abstract: The fight against a climate crisis has urged nations and the global community to cut emissions and to define ambitious environmental goals. This has highlighted the importance of the renewable energy (RE) industry. Germany has been one of the most active countries in RE adoption. In this vein, the purpose of this research is to study and identify key profitability determinants of unlisted German electricity-producing RE-companies, many of which have been supported by the German Feed-in Tariff (FIT). A multi-year analysis based on panel data from 783 companies for the years 2010–2018 is used. The results show that both company- and industry-specific profitability determinants are statistically significant, but the company-specific determinants seem to be more important. The results shed new light on what drives the profitability of private German RE companies during the period of financial aid from the government and are of use to managers, regulators and investors alike, e.g., when the effects of different regulatory climates and industry environments, as well as states of business life cycle are considered. Furthermore, the implications of this study have wider environmental and economic importance as the performance of the RE companies is critical in achieving the emission targets of the energy industry and ensuring a more sustainable energy production for the future.

Keywords: renewable energy; electricity production; unlisted companies; Germany; feed-in tariff

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1. Introduction

After 2010, the fight against the climate crisis intensified and supranational bodies started to act. In 2020, the EU Commission proposed a Climate Target plan of cutting carbon dioxide (CO_2) emissions by at least 55% by the year 2030 and set a goal of carbon neutrality by 2050 [1]. Germany has been one of the most active countries in turning to renewable energy (RE) as a remedy to tackle CO_2 emissions. The German RE markets are the fifth largest in the world (after China, US, Brazil, and India [2]) and are well established due to the long-lasting efforts by the German government to promote green energy with a Feed-in-Tariff (FIT) support mechanism. Transition in the RE support mechanism has already been started and new mechanisms will most likely be introduced.

This research focuses on uncovering the profitability determinants of unlisted German electricity-producing RE companies. Profitability is examined in terms of companies' yearly profit and loss statements and not from an investment or a plant operations perspective. This research falls under the umbrella of studies that concentrate on firm performance. Lebas and Euske (2007) [3] defined firm performance as a set of quantifiable financial and non-financial indicators that can be illustrated with a causal model, reflecting the future outcomes of current actions. The selected indicators of financial performance used in this study include measures of profitability such as the Return on Investment (ROI), Return on Assets (ROA), and Return on Equity (ROE) and measures of growth such as the growth of revenues and assets.

It is well known, see, e.g., [4] that the profitability indicators are prone to accounting manipulation, undervaluation of assets, and different depreciation policies, which makes comparing companies complicated. As we are looking only at German companies, the accounting regulation and the legal structures that all companies in the sample use are uniform and we expect that all companies in the sample act in a profit-maximizing way within the limits set by the law. While profitability can also be measured by using a more holistic set of indicators [5], we limit the focus to company-level profit indicators only.

The rest of this paper is constructed as follows: In the following section, the background and motivation of the study are discussed following the review of the literature and hypotheses. The second chapter introduces the data, selected variables, and the panel-data-method used in the analysis. The third chapter presents the results of the panel data analysis and the answers to the hypotheses made about the models used and the significance of different firm- and industry-specific determinants to firm profitability. The fourth chapter discusses the results in light of the previous research. Finally, the contribution of this paper is summarized and ideas for further research are discussed.

1.1. Background

This research is motivated by the lack of existing studies that focus on the profitability and the determinants of profitability of unlisted German electricity-producing RE companies. Thus, there is a research gap that the results of this research fill. In addition to understanding the profitability issues better, we wish to know what effect the German RE support mechanism, the Feed-in Tariffs, has had on company profitability. Understanding these issues is important because of the role of the energy industry in reaching the ambitious goals of carbon neutrality in Germany (see Figure 1).

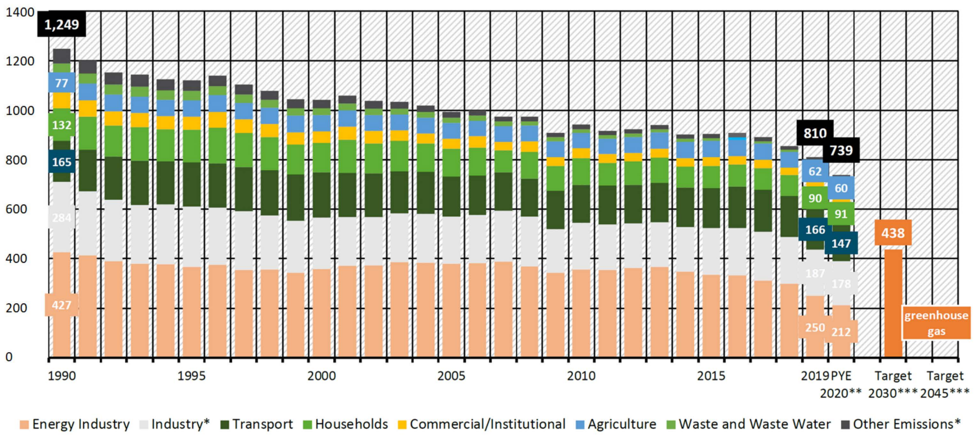

Figure 1. CO_2 emissions in Germany in millions of tons of CO_2 equivalents. (* Industry: Energy and process-related emissions from industry (1.A.2 & 2); Other emissions: Other combustion (rest of CRF 1.A.4, 1.A.5 military) & fugitive emissions from fuels (1.B) ** PYE: Previous Year-Estimate for 2020; *** Targets 2030 and 2045: according to the revision of the Federal Climate Protection Act (KSG) as of 12 May 2021) according to [6,7].

Renewable, green, or alternative energy all describe energy either in the form of heat, electricity, or fuel that is derived from constantly renewing natural sources and processes. The sources usually prescribed as renewables are solar, wind, geothermal, marine, hydro, and bioenergy. According to the European Commission (2021), in 2020, Germany's share of renewables in the gross final energy consumption was 18.6% and 45.4% in the gross power consumption. Germany has set a goal to increase the share of renewables in gross power consumption to 65% by 2030, and that by 2050 all electricity generated or consumed in Germany be greenhouse-gas neutral. (see, e.g., [8–10]). In 2020, the largest share of renewable electricity generation in Germany was by wind onshore power (42%), followed by solar (20%), and biomass (7%) [11].

Germany has been a renewable energy policy pioneer with its energy transition "Energiewende" that started as opposition to nuclear energy in the late 1970s. The long-term energy transition has included a reorientation of energy policy from the traditional fossil energy forms towards renewable energies along with the nuclear energy phase-out into concrete actions. By 2022, the last nuclear facility is set to shut down and the latest Coal Phase-Out Act mandates a gradual phase-out of coal-burning leading to all coal plants having to cease operations by 2038 [12,13].

In 1991, the Electricity Feed-in Law (EFL) was introduced in Germany. Its objective was to make sure that electricity produced from renewable energy sources had access to the grid. The electricity from renewable energy power plants was paid a premium price (Feed-in Tariff, FIT), a cost that was borne by the electricity supply utilities and their customers. As the support was highest for wind and solar plants, the law contributed to the expansion of renewable energy production, especially in the form of wind farms. [14]

According to IAE [15], the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) replaced the EFL in 2000 and obligates grid operators, instead of the suppliers, to buy renewable energy and to effectively pay the FIT. The tariffs were determined for each sector separately and according to the actual production costs, and upon initialization, the main target was to double the share of renewable electricity by 2010 [15]. The plants initially eligible for the FIT remuneration will soon face the end of the support period as Germany is shifting out from the FIT system. As of 2021, there is also a discussion about completely ending the renewables levy (EEG surcharge) that has been paid by electricity consumers. Possible discontinuation of the renewables levy may be offset by an increase in the price of CO_2 emissions, a part of the EU Emissions Trading System, and Germany's own national emissions trading [16,17].

The 2017 amendment to the EEG introduced public tenders, the goal of which is to aid the shift from FIT to a market-oriented price mechanism. From 2017 onwards, on-shore and offshore wind, solar and biomass projects have had to bid a price in an auction to ensure contracts for 20 years [8].

1.2. Review of Literature on Profitability Determinants

The determinants that explain profitability can be examined on different levels: the firm-level, industry-level, and country-level, or, for example, on regional or temporal levels. Early research on the topic emphasized the importance of industry structure and a competitive environment on firm performance through the Structure-Conduct-Performance paradigm [18] and the Porter's famous five competitive forces model [19]. Gradually, the focal point of research has shifted from thinking of the industry as an aggregate as the main determinant of profitability towards recognizing individual company characteristics as important profitability drivers [20]. This is also the focus in this research. According to the summary in [21], several variance decomposition analyses across industries, from the 1980s until 2007, reported that firm-specific effects explain from zero to 66% of the variance in firm profitability. In particular, in the manufacturing industry, the firm-level effects explain more variance than they do in other industries [21].

Capon et al.'s (1990) [22] meta-analysis covered results from 320 published studies on financial performance between the years 1921 and 1987 across industries, with different performance measures (see, Table 1). More recent studies [23,24] have found that profitability is positively affected by company size in terms of sales and as the number of employees. Goddard et al.'s (2005) [23] study on European firms implied that the relationship between company size in terms of assets and profitability is negative. They suggest that a rapid expansion of successful firms may have a negative influence on short-term profitability, while at the same time, the positive effect of market/industry concentration implies that costly strategies may be conducted to gain a larger market share.

Adner and Helfat (2003) [25] studied 30 firms in the energy industry and concluded that firm-level effects explain the largest share of variance in profitability. Westerman et al. (2020) [26] studied publicly listed energy firms located in Western Europe over the period of 2009–2015 and reported that firm size indicated by total assets and EBIT/total sales are positively correlated with return on assets (ROA), especially with renewable firms. They also found a negative relationship between Debt-to-Assets (D/A) and ROA, and that diversification has a negative relationship with firm profitability (ROA) in the energy industry. Jaraite and Kažukauskas (2013) [27] provided evidence that the higher profitability of the electricity production is related to the higher market concentration (a percentage of a market share of the (four) largest firms).

Table 1. Selected firm- and industry-specific determinants of profitability summarized from the results of a meta-analysis by Capon et al. (1990). +: significantly more positive than negative relationship, significance level 5%, −: significantly more negative than positive relationship, significance level 5%, Ns: count of positive vs. negative relationships reported not significantly different, significance level 5% [22].

Determinant Type	Determinant Name	Significance	Nr of Studies
Firm-specific	Leverage/Debt	−	23
	Capital Investment	−	29
	Diversification	−	17
	Growth in Sales	+	22
	Market Share	+	42
	Capacity Utilization	+	15
	Variability in Return	+	11
	Size (Sales)	Ns	48
	Size (Assets)	Ns	47
	Price (relative)	Ns	18
Industry-specific	Imports	−	19
	Exports	−	10
	Growth (Sales)	+	59
	Capital Investment	+	51
	Geographic dispersion (Production; reg. vs. nat.)	+	32
	Economies of scale	+	13
	Barriers of Entry	+	16
	Industry Concentration	+	99

A study by Tsai and Tung (2017) [28] on RE firms from across the world found that the share of renewables in the overall primary energy consumption has a significant and negative effect on the ROA of renewable energy companies. They also found that a nation's energy consumption impacts ROA negatively, whereas employee growth rate has a positive effect on ROA. We observe that companies typically tend to hire more people into profitable businesses. According to [29], the degree of innovation and the development of the technology sector nationally have been found to positively affect the performance of RE firms on the country level. Shah et al. (2018) [30] found mixed evidence on the effect of macro-level shocks on the return on RE investments. In their study, oil prices have had both a positive and a negative effect on the return on RE investments, depending on the level of government subsidies: an increase in oil price boosted the profitability of RE-companies operating in a market-driven regulatory environment.

A study by Hassan (2019) [31] analyzed 420 RE-companies from the OECD countries and reported a significant positive relationship between different RE support mechanisms, including the FIT, and accounting-based measures of financial performance (Earnings per share, Return on Capital Employed = ROCE). Milanés-Montero et al. (2018) [32] specifically analyzed the effect the FIT—which is also of interest in this paper—had on the performance of photovoltaic (solar) farms in Germany, Italy, France, and Spain. They report that the FIT had a positive statistically significant influence on the profitability of the firms when measured in terms of Return on Investment (ROI). The study also confirmed that among the firm-specific determinants, total assets and leverage had a significant positive effect on the photovoltaic firms' performance; the result is contrary to the one from the meta-analysis of [22]. Neves et al. used the generalized method of moments to study Portuguese energy companies' determinants during the periods of 2010–2014 [33] and 2011–2018 [34].

In summary, the previous literature across industries recognizes the determinants "size in sales" and "size in assets" with both positive and negative effects, and the growth in sales and assets with a positive effect on profitability. Leverage has mostly been found to have a significant negative effect on profitability, with the exception of the above-mentioned study on solar power firms. Liquidity has been found to have a positive effect on firm-level profitability. Furthermore, market concentration has been found to have a significant positive effect in most of the studies and these results are supported by the studies in the RE industry as well. Lastly, the Feed-in-Tariffs have been found to have a significant positive influence on profitability.

For this paper, a panel data analysis is run to investigate the subject from the perspective of unlisted German RE companies.

1.3. Hypotheses

We formulate three hypotheses based on the previous literature on profitability determinants of renewable energy. Specifically, we are interested in how important the firm-specific and industry-specific determinants are in the case of the data of non-listed German RE producers, and which determinants explain the largest variance in the selected profitability ratios.

The previous literature across industries has suggested that firm determinants (such as the financials chosen for this analysis) explain more variance in profitability than industry determinants, but that industry determinants, especially industry growth and concentration, are also significant. Furthermore, according to more recent studies on the markets, where the FIT support has been applied, the FIT has shown to be significant in determining the profitability of renewable electricity generators.

Based on the review of literature on profitability determinants, the following hypotheses were formed:

Hypothesis 1 (H1). *The model with industry-specific determinants and the model with firm-specific determinants are both significant when a 5% significance level is adopted in the statistical testing.*

Hypothesis 2 (H2). *The explanatory power of the included firm-specific determinants is higher than that of the included industry-specific determinants.*

Hypothesis 3 (H3). *The average annual Feed in Tariff (FIT) has a significant positive effect on the RE companies' profitability.*

2. Data and Methods

The data which the results are based on were acquired from the Amadeus database (hosting the data of the 565,000 largest public and private companies in 43 European countries) with a query (Applied industry classification code "3511", "production of electricity" in NACE Rev. 2 based classification system) with the following conditions: "active and not bankrupt"; "operating in Germany"; "generating electricity in the RE industry (solar, wind, biomass, hydro, and geothermal)"; "no conventional electricity production"; "not publicly listed". The query returned data for 783 electricity-producing companies with financial accounts available for the period of 2010–2018. The sampling period was chosen based on the availability of the data and the fact that the FIT-support was active during the years of the sampling period for all RE technologies studied in this paper.

The retrieved data were sorted by name and "trade description" according to the activity of generating or transmitting renewable electricity from any RE source. The data include companies in all the above-mentioned RE sectors except for geothermal power and some of the firms are active with multiple RE technologies.

Company-specific data were combined with data on feed-in tariffs and energy statistics. Data on feed-in tariffs and the industry and energy statistics for the nine years in question were obtained from the European Commission's Eurostat statistics database [35], the World Bank database [36], and the OECD [37] databases.

Company size was used to classify the companies into two cohorts, for which analysis was performed separately; the cohorts were constructed by combining the companies in the Amadeus size categories "very large" and "large" into one cohort (n = 401) and companies in categories "medium" and "small" into another (n = 332), see Table 2 for information about these categories. The decision was made to study the possible difference between SMEs and large firms. That is, the category "Very Large" was excluded from the study, representing a minor share of the overall data when taking into account the number of companies (9/733 companies = 1.2%). Although the cohort of large companies is larger, in the analysis used, the observations of the large companies are significantly lower than with the SMEs and stay at around 100 observations due to the unbalanced panel.

Table 2. Company size categories and the resulting number of firms in the analyzed data. Size categories adopted from Amadeus.

	Very Large	Large	Medium	Small
Operating Revenue	≥100 M€	≥10 M€	≥1 M€	<1 M€
Total Assets	≥200 M€	≥20 M€	≥2 M€	<2 M€
Employees	≥1000	≥150	≥15	<15
Firms in Data	9	392	278	54

2.1. Variable Selection

Three dependent variables in the measurement of profitability were selected: Return on Equity (ROE), Return on Assets (ROA), and Return on Capital Employed (ROCE). ROE implies the average annual return generated for the equity owners, ROA is the return generated concerning the total assets in the firm and an indicator of how efficiently the company is using its assets. ROCE is a measure for comparing companies in capital-intensive industries (with a lot of debt), as it indicates how well a company is using its overall available capital. The definitions used for the three dependent variables are as follows:

$$\text{ROE} = [\text{Net Income} + \text{Taxes}]/[\text{Average Stockholders' Equity}] \quad (1)$$

$$\text{ROA} = [\text{Net Income} + \text{Taxes}]/[\text{Average Total Assets}] \quad (2)$$

$$\text{ROCE} = [\text{Net Income} + \text{Taxes}]/([\text{Average Total Assets}]\text{-}[\text{Current liabilities}]) \quad (3)$$

The independent variables were selected in such a way that they include both firm-specific and industry-specific determinants. The variables were selected based on earlier choices made in the previous literature. The "net income" used as a control variable includes the effect of taxes (net of tax) in order to eliminate company-specific efforts to minimize taxes. The firm variables were retrieved from the Amadeus database and the industry variables from selected databases (see Table 3). The annual average Feed-in-Tariff rates for solar-, biomass-, geothermal-, wind-, and hydro-energy are studied for the effect on profitability for each one of the studied years.

Table 3. Selected independent variables, their specifications, and the source of data. Explanations: * Annual percentage growth rate of GDP per capita in €. GDP per capita is the gross domestic product divided by midyear population. ** Market share of the largest generator in the electricity market. *** (Share of renewable energy sources in gross power consumption).

Original Variable	Specification	Analyzed Variable	Source
	Company Variables		
Net Income inc. taxes	Salescosts general expenses and interest+ taxes, in thousands €	Net Income	Amadeus
Total Assets	$LOG\_Assets = LOG(Total Assets)$	Company Size (assets)	Amadeus
Total Assets	$Assets\_G = \frac{Total Assets_t - Total Assets_{t-1}}{Total\ Assets_t} \times 100$	Growth in Assets	Amadeus
Sales	$Sales\_G = \frac{Sales_t - Sales_{t-1}}{Sales_t} \times 100$	Growth in Sales	Amadeus
Sales	$LOG_{Sales} = LOG(Sales)$	Company Size (sales)	Amadeus
Debt	$D\_E = \frac{Debt_t}{Shareholder\ funds_t}$	Leverage (Debt/Equity)	Amadeus
Debt	$D\_A = \frac{Debt_t}{Total\ Assets_t}$	Leverage (Debt/Assets)	Amadeus
Current ratio	$CurrentRatio = \frac{Current\ Assets_t}{Current\ Liabilities_t}$	Liquidity	Amadeus
	Industry Variables		
Average annual power price for households	Elecpriceh (€/kWh taxes and renewable levies included)	Price level	Eurostat
Annual final electricity consumption	$ElecCons\_G = \frac{ElecCons_t - ElecCons_{t-1}}{ElecCons_{t-1}} \times 100$ (GWh)	Change of annual final electricity consumption	Eurostat
Economic growth (GDP per capita) *	$GDPG = \frac{GDPG_t - GDPG_{t-1}}{GDPG_{t-1}} \times 100$	Economic Growth	World Bank
Market concentration (annual) **	$Marketconcentration\_G = \frac{Marketconcentration_t - Marketconcentration_{t-1}}{Marketconcentration_{t-1}} \times 100$	Industry/Market concentration	Eurostat
Share of renewables ***	$Elecreshare_G = \frac{Elecreshare_t - Elecreshare_{t-1}}{Elecreshare_{t-1}} \times 100$	Industry growth	UBA Arbeitsgruppe Eneurbare Energien-Statistik (AGEE-Stat)
Average annual Feed-in-Tariff per renewable energy source	FITavg (Average annual FIT for all renewable energy sources)	Level of RE incentive	OECD StatisticsOECD.stat

Two of the independent variables, [TotalAssets] and [Sales], were log-transformed to make them approximately follow the normal distribution required in the statistical analysis. From the industry-specific determinants, the "change from the previous year's share of RE in electricity consumption" was chosen as a proxy for industry growth. Market concentration was also added as a growth rate, "a percentage increase from the previous year's share of the largest electricity generator in the industry". We found it important to study the separate effects of the company's size in terms of assets and in terms of sales, as well as the growth in sales and assets, as these variables have different implications.

As it is not possible to acquire the amount of FIT-support received by individual companies from public databases, an attempt was made to include them in the quantitative analysis model and to test whether they (partially) explain the variance. The average FIT used in the analysis is an aggregate mean of the average annual FIT received by all the RE sectors.

The selected variables that had a significant correlation with some another independent variable were removed and only one variable from such a pair was kept in the analysis. For the purposes of this research, the variables with a significant correlation larger or equal to ± 0.6 to another independent variable were removed from the analysis. More specifically, in the SME data, a strong and statistically significant (5% level) positive correlation of 0.89 between the leverage variables D/A and D/E was found, thus D/E was excluded from the analysis of the SMEs. A strong negative and statistically significant correlation (-0.64) between the Electricity price (Elecpriceh) and the growth rate of the Share of Renewables in Electricity consumption (Elecreshare_G) was found. Electricity price also correlates strongly with the growth rate of Electricity consumption (ElecCons_G) (-0.62) and the annual average Feed-in Tariff price (Fitavg) (-0.77); thus, the variable Electricity price was removed from the analysis in both data sets.

2.2. Method

The collected data included both a time-series dimension and a cross-sectional dimension, and were thereby transformed into panel-data form. Each firm is observed repeatedly in the vertical dimension with a length of (the number of individuals), I $\times$ (the number of periods), T, and the dependent and independent variables K are presented in the horizontal dimension. The overall size of the matrix equals I $\times$ T $\times$ K observations.

What is typical to panel data and distinguishes them from simple time-series regression is the presence of unobserved heterogeneity that is due to the cross-sectional dimension. Unobserved heterogeneity is the time persistent differences between the individual studied units also called "individual effects" that cannot be estimated with the simple pooled (OLS) regression [38]. When heterogeneity is present in the data, which is typically the case, a model able to take it into account should be used. For this reason, fixed effects and random effects -models that can handle longitudinal and heterogeneous data are used in this research. The fixed effects (FE) or "within"-estimator used has the following form:

$$Y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k \times X_{it}^{k} + e_{it} + a_i \tag{4}$$

The within-estimator models the time-invariant heterogeneity in the unknown parameter a_i. The data are transformed by time demeaning all the variables, a.k.a. subtracting the variables' individual means over time from all the variables. The result is a formulation in terms of deviations from the individual means. The a_i term, as well as the constant β_0 (see, Equation (4)) that is simply the individual mean, and all the time-invariant independent variables cancel out in this calculation. This eliminates the problem of individual effects, hence it is said to be "fixed" [38].

The coefficients of the FE model can be interpreted as the effect that the unit of change from the individual mean of the respective independent variable has on the same individual's dependent variable from its mean. The main downside of the FE estimators is that one cannot include time-invariant independent variables since they would be canceled out in the model estimation. This simplifies the estimation process but fails to account for the time-invariant variables although they could potentially be significant in determining the values of the dependent variable. To deal with the possible handicaps of the FE in the context of the studied data, a random-effects (RE) model is also applied.

In the random-effects model (RE), the individual differences are allowed and the variation between the individuals is assumed to be random and uncorrelated with the independent variables. The random individual effects are modeled as the error term u_i. The RE-effects model used is defined as follows:

$$Y_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k \times X_{it}^k + e_{it} + u_i \quad (5)$$

In Equation (5), the intercept corresponds to the mean of the unobserved heterogeneity and the error term u_i is the random time-invariant heterogeneity specific to the individual unit. In the random-effects model, the generalized least squares (GLS) estimator is used. The data are "quasi time-demeaned", which means that a part of the within-individual variation is taken out. For a more comprehensive introduction to the Random Effects model, see [39].

The application of fixed-effects and random-effects models was considered to be sufficient for the purposes of this research in terms of the reliability of the results. We point out that the use of more advanced methods, such as the generalized method of moments (GMM), which control for the violations of the random-effects model and the possible endogeneity problems in the data may reveal deeper and better results from the same data. The use of more advanced methods is left as a topic for future research.

3. Results

Both Fixed- and Random-Effects models are used to obtain results for both company-size cohorts. The results for both the FE and RE analysis are listed in the Appendix A (Tables A1 and A2). To find out whether the RE model provides new information in addition to the results from the FE estimation, the Hausman test, which tests the presence of individual effects by comparing the FE and RE models' coefficients, was performed. If there are no significant differences, the individual effects are random and thus either of the estimators can be used [40]. The alternate hypothesis (p-value < 0.05) is that the FE and RE coefficients are different from each other and in such a case, only the FE estimator is consistent.

Tests on heteroskedasticity and autocorrelation indicate that they were present regularly. Arellano's (1987) [41] and White's heteroskedasticity robust standard errors [42] are used in the analysis when heteroskedasticity is present (see Tables A1 and A2).

3.1. Results for the SME Cohort

The results for the SME cohort are presented in Table 4. The results from the Hausman test (at the 5% significance level) imply that individual effects are present in the data and that the FE estimator should be used.

The company determinants appear significant mostly when profitability is measured with ROA and ROCE. Net income (Netincome), controlling for the nominator in the profitability ratios, is significant and positive in all six tests, with a small effect on profitability as expected (around 0.055, see Table A1). Company size in sales (LOG_Sales) is statistically significant and positive in three out of six of the tests, with a larger effect on profitability when measured with ROA and ROCE (3.890, 8.081, 6.959) but the effect is non-significant on ROE. Size in Assets (LOG_Assets) is statistically significant only at the 10% level in one of the tests (3.658). Liquidity (CurrentRatio) is significant at the 10% level in three of the tests and positive with a small effect on ROA and ROCE (0.649, 0.580, 0.574) and Leverage (D_A) is significant at the 5% level once with a large negative effect on ROCE (−4.131). Growth in sales (Sales_G) is significant at the 10% level with a positive effect on ROA (0.013). Growth in assets (Assets_G) is not significant in any of the tests (see Table A1).

Table 4. Summary of FE model results for both the SMEs and large firms. Legend: +: positive relationship; −: negative relationship, ***: significance level 1%; **: significance level 5%, *: significance level 10%, Ns: not significant.

	SMEs		Large Firms	
Determinant's Effect from Previous Studies	**Effect**	**Occurrence n/6 Number of Tests**	**Effect**	**Occurrence n (Number of Tests)**
Net Income	+	6/6 ***	+	6/6 ***
Size (sales) +	+	3/6 **	+	6/6 **
Size (assets) +	+	1/6 *	−	6/6 **
Liquidity +	+	3/6 *	−	1/6 **
Leverage −	−	1/6 **	+	1/6 **
Growth in sales +	+	1/6 *		Not included
Growth in assets +	Ns	Ns	+	1/6 *
Change in the Electricity Consumption −	−	5/6 ***	−	3/6 **
Change in the share of RE in overall electricity consumption (industry growth) +	+	3/6 ***	+	3/6 **
Change in the Market Concentration +	+	5/6 ***	+	1/6 **
FIT average +	−	5/6 ***	−	3/6 **
GDP +	+	1/6 **	Ns	Ns
Electricity Price −	Not included		Not included	

Among the industry determinants, the variables proxying for the industry growth are significant at the 5% level. These include Change in the Electricity Consumption (ElecCons_G) with a moderate (−1.343, −0.607, −0.398, −0.646, −0.486) negative effect in five out of the six tests and Change in the share of RE in the overall electricity consumption (Elecreshare_G) in three out of the six tests, with a smaller positive effect (0.316, 0.081, 0.114) on profitability. The change in the market concentration a.k.a. the market share of the largest generator in the market (Marketconcentration_G) is significant at the 5% level in five out of the six tests, with a small or moderate positive effect (0.438, 0.343, 0.122, 0.178, 0.061). The GDP growth rate (GDPG) is once significant at the 5% level with a positive (0.146) effect on ROA. The annual average Feed-in Tariffs across the RE sectors is significant at the 5% level in five out of the six tests with a very large negative effect on profitability (−162.8, −110.8, −46.6, −30.4, −52.5) (see Table A1).

This significant and large effect is explained by the unlikeliness of the one unit rise in the independent variable as the average FIT range in these data is from 0.11 to 0.19.

3.2. Results for the Large Firm Cohort

When analysis is repeated with the large firm cohort, the Hausman test again indicates that the FE estimator should be used with all the dependent variables (see Table A2). The results for the large companies are summarized in Table 4.

Of the company determinants, Net income is significant at the 5% level in all six tests, with a similar small positive effect (0.011, 0.010, 0.002, 0.003) as with the SME cohort. Company size in sales (LOG_Sales) is statistically significant at the 5% level and positive in all tests with a larger effect on profitability ratios (12.4, 14.5, 2.7, 2.6). Size in Assets (LOG_Assets) is statistically significant at the 5% level in all six tests, as well as showing a larger negative effect on profitability (−16.7, −21.3, −5.04, −4.6, −5.8, −7.1). Liquidity (CurrentRatio) is once significant at the 5% with a larger negative effect (−3.225) on ROE. Leverage measured with Debt to Assets (D_A) is significant at the 5% level once with a large positive effect on ROCE (7.113). Growth in sales (Sales_G) is not included in the analysis due to the very low observation count in the large firm cohort (n = 249) Growth in assets (Assets_G) is significant once at the 10% level with a small positive effect (0.04) on ROA (see Table A2).

Among the industry determinants, the Change in the Electricity Consumption (ElecCons_G) is significant at the 5% level in three out of the six tests, with a large or moderate (−2.6, −0.735, −0.901) negative effect. The Change in the share of RE in the overall electricity consumption (Elecreshare_G) is significant at the 5% level in three out of the six tests, with a smaller positive effect (0.457, 0.112, 0.108) on profitability. The change in the market concentration (Marketconcentration_G) is significant at the 5% level once with a moderate positive effect (0.643) on ROE. The GDP growth rate (GDPG) is not significant in any of the tests. The annual average FIT is significant at the 5% level in three out of the six tests, again with a very large negative effect (−289.3, −87.5, −91.1). The industry determinants' effects are not significant in the tests of the model where both firm and industry determinants are included (see Table A2).

3.3. Testing the Hypotheses

According to the analysis results, specifically based on the results from the Fixed Effects model, there is clear evidence to support Hypothesis 1 "*The model with industry-specific determinants and the model with firm-specific determinants are both significant when 5% significance level is adopted in the statistical testing*". In both company-size cohorts, all the models are statistically significant.

When it comes to Hypothesis 2 "*The explanatory power of the included firm-specific determinants is higher than that of the included industry-specific determinants*", the explanatory power for the models with firm-specific determinants for SMEs and Large firms respectively are 0.74/0.76 (ROE), 0.77/0.91 (ROA) and 0.72/0.88 (ROCE), while the R2 for the industry-specific determinants are 0.149/0.23 (ROE), 0.177/0.33 (ROA), and 0.155/0.28 (ROCE). This result means that Hypothesis 2 can be accepted. The models that combine both determinants have the explanatory power of 0.762/0.78 (ROE), 0.796/0.91 (ROA), and 0.74/0.89 (ROCE) (Appendices A and B).

The analysis results of the firm-specific determinants imply that the size in terms of assets matters when a company is large and that the size in assets has a negative effect on the profitability of large firms. Net income and Log of sales appear to have a consistent and significant positive effect on profitability ratios with both firm cohorts, based on the analysis (see Table 4).

Leverage or liquidity did not appear to be consistently significant for neither size-group. When Debt to Assets (D_A) was significant, it was negative for the SMEs and positive for the large firms. Growth in Assets or Sales was not consistently, or at all, significant with either of the cohorts, indicating that the firm-specific determinants related to size and net income, as well as, the ones related to liquidity and leverage, together explain most of the variance in the profitability ratios.

In the analysis of the industry-specific determinants, the growth from the previous year in the share of renewables in electricity consumption appeared to have a significant positive effect on the profitability ratios. The change from the previous year's market concentration had a significant and positive effect on profitability more or less consistently with the SMEs. The change from the previous year's electricity consumption had a significant negative effect on profitability ratios, without exception, in both samples. However, in the sample of large firms, these effects disappeared, when both the firm-specific and industry-specific determinants were included in the FE model. This finding also supports the second hypothesis with regards to the explanatory power of the firm-specific determinants being remarkably higher than that of the industry-level determinants.

Based on the analysis, there was no support for Hypothesis 3: "*The average annual Feed in Tariff (FIT) has a significant positive effect on the RE companies' profitability*". The annual average FIT does seem to have a statistically significant effect on profitability, but the effect is opposite to what was expected. The variable had a negative effect on profitability with both firm size categories in eight tests out of the total twelve. However, the share of FIT-supported firms in the data was unknown in the analysis done in this research and the negative effect could be on the firms that were not receiving any FIT at the time of the analysis.

4. Discussion

It can be observed that the results are generally in line with the results obtained in previous studies of a similar type (see Tables 1 and 4). This study extends the research to cover the unlisted German companies that have, to the best of our knowledge so far been left "unattended" by previous research. The results presented here widen the scope of knowledge we have about the factors that affect the profitability of companies operating within the German RE industry. In this respect, the finding is that the unlisted companies do not differ from the previously studied companies listed.

Based on the results, it is clear that the firm-specific determinants outrank the industry-specific counterparts in importance, as was also suggested by the previous studies. One of the findings is that company size in terms of assets matters when the firm is large and that the size in assets has a negative effect on the profitability of large firms. The size of assets is not significant with regard to the profitability of the SMEs. This result is supported by previous research [23] that suggested that the rapid expansion of firms may have a negative influence on profitability, implying that large firms may follow costly strategies to gain a bigger share of the markets. One explanation could be that in an investment phase (which is ongoing on the German RE markets), there are profitability lags. The capital investment intensity (data which was not available for this analysis) is also proven to be a determinant of profitability and could explain the negative effect of the assets in case the effect of the capital investment intensity is significantly negative for larger firms, as was pointed out by the previous research.

The positive relationship between the liquidity and profitability of the SMEs may be an implication of the power of slack income that the firms can invest to generate profit. Then again, leveraging profit might be the chosen strategy for large firms that have the position to take more risks. Nonetheless, too many and/or far-fetching conclusions should not be drawn about the determinants that appeared significant less consistently in the analysis.

The average Feed-in-Tariff had a negative effect in most of the tests with the SMEs and in three tests with large firms. These findings are not in line with the previous results [27,31] and our expectations. The previous analyses found that the FIT has a positive effect on the profitability of electricity firms, but the data used were from the companies that in fact received support from the FIT. The share of FIT-supported firms in the data used in this study is unknown to us. Thus, the negative effect result may be caused by the effect of FIT on firms that did not receive FIT-support and were affected negatively by the support their competitors received. The authors conclude that the counter-intuitive result can also be a consequence of the aggregation method used in treating the variable and the reader is suggested to take the result as preliminary.

The change in electricity consumption had a negative effect on profitability, as suggested by previous studies (in past studies energy consumption was analyzed, instead of electricity consumption). This result may reflect the increasing competition in the industry, as the demand has only increased during the period of the analysis in terms of the final electricity consumption in the country. Furthermore, the trend of the market concentration growth rate in the data of this analysis shows that the competition is intensifying in the industry structure, and this seems to especially benefit especially the SMEs according to the analysis. Moreover, the share of renewables seemed to be beneficial for both the SMEs and large companies.

5. Conclusions

The objective of this study was to examine the profitability determinants of unlisted German renewable energy firms that produce electricity. The models with firm-specific determinants had a higher explanatory power than models with the industry-specific determinants only. The results are mostly in line with results from previous similar studies. German private RE companies during a period of active remuneration have not been studied before from the same perspective and the results should be useful in understanding what determines the profitability of these companies. The results are usable in forecasting the same also in other countries that have applied Feed-in-Tariff-based support to boost the production of renewable electricity. Furthermore, a separate analysis was conducted for the SMEs and Large companies which offers insight into the differences between these size cohorts.

The results of the study are of use to managers of the RE companies when the effects of different industry environments and states of business life cycle are considered, as the authors found that the smaller and medium sized companies in terms of returns on total assets might be more affected by market concentration. Moreover, the result implying that the larger companies are negatively affected by size, and that the effect is the opposite with smaller companies, is of interest to managers and investors alike. For German policy-makers, the results mean that within the scope of this research, no remarkable difference between listed and unlisted companies was uncovered in terms of the determinants that drive profitability. This information is important from the (rate-of-return) regulation point of view as it means the same regulation model can be used for both company types, from the point of view of this context.

One of the limitations of the analysis was the quality of data, as the number of observations was limited. This was especially true for the data on large companies. The analysis did not include the largest companies on the market as they were few in number (nine out of 733 companies). In addition, according to the names and descriptions of the companies, the data did not include any companies producing energy from geothermal sources. The sample sizes differed depending on the model, as typically is the case with unbalanced panel data.

There are certainly many other determinants—not addressed in this paper—that could explain firm profitability, such as managerial capabilities, other management-related variables, and investment intensity. As a topic of future research, the corporate-parent and dynamic effects and the more technical variates related to the capacity of the power facility, etc., could be added to the analysis if relevant data become available. The analysis conducted in this paper could not distinguish the firms that benefited or suffered from the FIT support, hence, the observed negative effect of the average FIT, calculated with the annual FIT level of all the RE sectors, is somewhat debatable. This is another topic for further research and for repetitive studies to understand the reasons behind these differences. Possible methodological additions and avenues for further study would be opened by using a correlated random effects model, which can provide an option for estimating the random effects model even if the assumptions of the random effects model do not hold (see, e.g., [40,43,44]) and by using the generalized method of moments, which would provide yet another methodological perspective to the study.

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Appendix A. Panel Data Model Results for German RE-Companies Fitted in This Study

Table A1. Panel Data Fixed Effects models for the SMEs.

	ROE			ROA			ROCE		
	(FE Firm)	**(FE Ind)**	**(FE Both)**	**(FE Firm)**	**(FE Ind)**	**(FE Both)**	**(FE Firm)**	**(FE Ind)**	**(FE Both)**
CurrentRatio	1.573		1.434	0.649 *		0.580 *	0.574 *		0.500
	(1.647)		(1.771)	(0.335)		(0.301)	(0.328)		(0.476)
Netincome	0.055 ***		0.053 ***	0.008 ***		0.008 ***	0.004 ***		0.004 ***
	(0.012)		(0.011)	(0.002)		(0.002)	(0.001)		(0.001)
D_A	13.329		24.475	−4.752 *		−3.137	−4.131 **		−2.528
	(26.528)		(27.102)	(2.556)		(2.621)	(2.206)		(2.986)
LOG_Sales	8.878		4.909	3.890 **		2.788	8.081 ***		6.959 ***
	(9.380)		(9.437)	(1.604)		(1.753)	(1.478)		(2.067)
LOG Assets	−5.590		7.736	−0.739		3.658 *	−0.882		3.494
	(8.279)		(13.782)	(0.710)		(2.004)	(0.572)		(2.456)
Assets_G	0.146		0.037	0.023		−0.008	0.044		0.012
	(0.279)		(0.310)	(0.022)		(0.028)	(0.028)		(0.031)
Sales_G	0.013		0.027	0.007		0.013 *	0.010		0.015
	(0.038)		(0.046)	(0.006)		(0.007)	(0.006)		(0.009)
Elecreshare_G		0.316 ***	0.052		0.081 ***	0.004		0.114 ***	0.020
		(0.074)	(0.072)		(0.016)	(0.013)		(0.020)	(0.012)
Marketconcentration_G		0.438 ***	0.232 **		0.122 ***	0.048 *		0.178 ***	0.061 **
		(0.136)	(0.105)		(0.031)	(0.026)		(0.043)	(0.030)
GDPG		0.025	0.317		0.188 *	0.146 **		0.088	0.144 *
		(0.443)	(0.356)		(0.103)	(0.068)		(0.141)	(0.085)
ElecCons_G		−1.343 ***	−0.851		−0.607 ***	−0.398 **		−0.646 ***	−0.486 **
		(0.516)	(0.881)		(0.117)	(0.191)		(0.153)	(0.236)
Fitavg		−162.755 ***	−110.755 **		−46.639 ***	−30.410 **		−54.524 ***	−31.859 *
		(23.972)	(50.823)		(5.296)	(14.077)		(7.565)	(17.270)
Observations	222	746	222	264	936	264	261	860	261
Hausman (p)	0.0329	1.488×10^{-12}	0.0026	0.0028	$<2.2 \times 10^{-16}$	0.0026	8.969×10^{-6}	$<2.2 \times 10^{-16}$	1.466×10^{-6}
Heteroskedasticity (p)	1.443×10^{-12}	0.6913	3.559×10^{-9}	1.19×10^{-7}	0.1647	4.027×10^{-7}	5.013×10^{-13}	0.6848	$<2.2 \times 10^{-16}$
Autocorrelation (p)	1.435×10^{-5}	1.779×10^{-5}	0.0001	0.0596	0.0733	0.01	0.3852	0.0366	0.0589
R^2	0.742	0.149	0.762	0.777	0.177	0.796	0.720	0.155	0.740
F Statistic	55.067 ***	17.901 ***	34.490 ***	83.173 ***	28.388 ***	52.554 ***	60.122 ***	21.834 ***	37.702 ***
	(df = 7; 134)	(df = 5; 511)	(df = 12; 129)	(df = 7; 167)	(df = 5; 659)	(df = 12; 162)	(df = 7; 164)	(df = 5; 594)	(df = 12; 159)

Note: Robust SEs used; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table A2. Panel Data Fixed Effects models for the Large firms.

	ROE			ROA			ROCE		
	(FE firm)	**(FE Ind)**	**(FE Both)**	**(FE Firm)**	**(FE Ind)**	**(FE Both)**	**(FE Firm)**	**(FE Ind)**	**(FE Both)**
CurrentRatio	−3.245 ** (1.513)		−2.850 (1.954)	0.012 (0.128)		−0.084 (0.159)	−0.293 * (0.175)		−0.409 (0.258)
Netincome	0.011 *** (0.003)		0.010 *** (0.003)	0.002 *** (0.0003)		0.002 *** (0.0003)	0.003 *** (0.0003)		0.002 *** (0.0004)
D_A	10.485 (21.431)		8.289 (25.071)	−0.357 (3.022)		0.137 (2.766)	7.113 ** (3.435)		3.943 (8.211)
D_E	1.700 (1.660)		1.571 (1.346)	−0.075 (0.202)		−0.098 (0.193)	−0.196 (0.204)		−0.151 (0.306)
LOG_Sales	12.386 *** (4.174)		14.502 ** (5.786)	2.677 *** (0.555)		2.584 *** (0.698)	2.458 *** (0.821)		2.864 ** (1.216)
LOG_Assets	−16.704 ** (7.425)		−21.314 ** (10.662)	−5.041 *** (0.762)		–4.576 *** (0.956)	–5.819 *** (1.100)		−7.060 ** (3.046)
Assets_G	0.191 (0.156)		0.158 (0.154)	0.040 * (0.023)		0.035 (0.024)	0.040 (0.025)		0.041 (0.030)
Elecreshare_G		0.457 *** (0.144)	0.012 (0.122)		0.112 *** (0.034)	−0.011 (0.020)		0.108 *** (0.039)	−0.009 (0.022)
Marketconcentration_G		0.643 ** (0.270)	−0.135 (0.178)		0.116 * (0.067)	−0.037 (0.030)		0.136 * (0.079)	−0.059 (0.045)
GDPG		−0.767 (0.834)	0.570 (0.710)		−0.301 (0.195)	−0.065 (0.158)		−0.190 (0.184)	−0.152 (0.148)
ElecCons_G		−2.550 *** (0.847)	0.225 (0.590)		−0.735 *** (0.210)	0.094 (0.115)		−0.901 *** (0.242)	0.283 (0.377)
Fitavg		−289.273 *** (46.056)	36.929 (43.354)		−87.543 *** (5.805)	−3.499 (5.822)		−91.133 *** (13.324)	11.606 (22.618)
Observations	115	359	115	111	391	111	118	415	118
Hausman (p)	0.0031	1.185×10^{-8}	4.26×10^{-5}	5.701×10^{-8}	1.071×10^{-6}	0.0002	6.072×10^{-6}	2.44×10^{-5}	2.235×10^{-8}
Heteroskedasticity (p)	6.186×10^{-14}	0.0401	6.286×10^{-13}	0.2226	0.0851	0.0018	0.0292	0.6794	0.4192
Autocorrelation (p)	0.0186	0.5085	0.0452	2.878×10^{-7}	0.5979	4.194×10^{-7}	7.336×10^{-7}	0.972	1.024×10^{-5}
R^2	0.758	0.232	0.775	0.912	0.326	0.918	0.882	0.275	0.893
F Statistic	25.897 *** (df = 7; 58)	14.707 *** (df = 5; 243)	15.237 *** (df = 12; 53)	84.815 *** (df = 7; 57)	26.662 *** (df = 5; 276)	48.709 *** (df = 12; 52)	63.899 *** (df = 7; 60)	21.451 *** (df = 5; 283)	38.182 *** (df = 12; 55)

Note: Robust SEs used; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Appendix B. Descriptive Statistics for Both Cohorts

Table A3. Descriptive statistics for the SMEs.

Statistic	N	Mean	St. Dev.	Min	Pctl (25)	Pctl (75)	Max
CurrentRatio	1062	1.320	0.813	0.000	0.702	1.869	3.608
Netincome	910	43.514	139.702	−290.132	−39.599	130.055	385.324
D_A	1523	0.833	0.153	0.418	0.737	0.951	1.270
D_E	1315	2.837	2.349	−3.287	1.157	4.247	8.877
LOG_Sales	694	7.004	0.652	5.445	6.639	7.442	8.556
LOG_Assets	1634	8.827	0.815	6.488	8.278	9.473	10.873
Assets_G	1092	−5.954	3.727	−14.918	−8.180	−3.608	3.256
Sales_G	488	1.780	13.179	−35.871	−8.158	11.301	40.249
Elecreshare_G	2696	10.672	6.054	0.317	6.356	15.022	20.000
Marketconcentration_G	2696	−1.391	5.278	−9.375	−5.057	1.490	6.338
GDPG	3033	2.085	1.273	0.418	1.268	2.602	4.180
ElecCons_G	2696	0.035	1.419	−2.165	−0.540	0.480	3.032
Fitavg	3033	0.154	0.029	0.115	0.126	0.176	0.193
Elecpriceh	3033	0.283	0.022	0.241	0.264	0.298	0.305
Elecpriceh_G	2696	2.832	3.728	−1.788	0.380	4.421	10.795
ROE	877	7.384	16.862	−37.857	−2.087	15.638	57.278
ROA	957	1.039	2.797	−6.129	−0.757	2.853	8.237
ROCE	879	3.948	3.433	−4.724	1.685	6.082	12.647

Table A4. Descriptive statistics for large firms.

Statistic	N	Mean	St. Dev.	Min	Pctl (25)	Pctl (75)	Max
CurrentRatio	1070	1.263	0.886	0.000	0.539	1.767	3.889
Netincome	416	536.546	870.148	−1715.000	−44091	1034.094	2780.630
D_A	1315	0.852	0.148	0.429	0.760	0.973	1.288
D_E	1136	3.051	2.938	−5.431	0.792	4.712	11.245
LOG Sales	404	8.543	0.901	6.231	8.028	9.216	10.993
LOG Assets	1215	10.381	0.440	9.246	10.135	10.663	11.521
Assets_G	878	−5.162	4.447	−16.586	−7.534	−3.282	7.458
Sales_G	249	2.116	12.840	−29.960	−6.934	11.510	36.213
Elecreshare_G	3208	10.672	6.053	0.317	6.356	15.022	20.000
Marketconcentration_G	3208	−1.391	5.278	−9.375	−5.057	1.490	6.338
GDPG	3609	2.085	1.273	0.418	1.268	2.602	4.180
ElecCons_G	3208	0.035	1.419	−2.165	−0.540	0.480	3.032
Fitavg	3609	0.154	0.029	0.115	0.126	0.176	0.193
Elecpriceh	3609	0.283	0.022	0.241	0.264	0.298	0.305
Elecpriceh_G	3208	2.832	3.728	−1.788	0.380	4.421	10.795
ROE	1048	7.704	16.897	−37.857	−1.915	16.088	57.278
ROA	394	2.259	3.507	−6.645	−0.119	4.274	11.106
ROCE	424	4.754	3.985	−5.799	1.854	7.074	15.057

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