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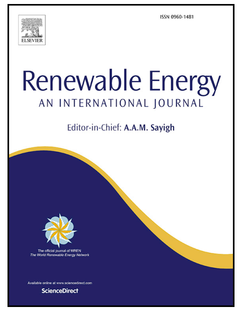

The financial performance of sustainable power producers in emerging markets

T. Schabek

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Tomasz Schabek: Conceptualization, Methodology, Writing, Editing.

Tomasz Schabek, Corresponding author,
Faculty of Economics and Sociology,
University of Lodz,
POW 3/5, 90-255 Lodz,
90-214 Lodz, Poland,
tomasz.schabek@uni.lodz.pl

The financial performance of sustainable power producers in emerging markets

Schabek T. [1,*]

Abstract:

This research provides novel results and contributes to the existing literature by: (1) introducing into the analysis new variables that link the type of renewable resource (solar, wind) with financial performance; (2) studying private and public firms whose main activity is only renewable power production; (3) analyzing a large group of emerging markets, and (4) providing an overall comparison of the financial performance of fossil fuel-based vs. renewable energy-based power producers. We acquired a large longitudinal dataset describing only renewable energy companies from 16 emerging markets in the period from 2000 to 2017. The study provides comprehensive results from a variety of panel regressions that explain the return on assets (ROA) and return on equity (ROE). The results regarding the type of renewable resource indicate that ROA is higher by 0.09 for solar power producers. The legal form of the company (private vs. public) does not impact ROA but indicates that ROE is lower by 0.09 for public companies. The results are mostly similar regarding the return on equity. The results indicate that the new variables introduced into the investigation are relevant in determining the financial performance of sustainable power producers.

Keywords: renewable energy; financial performance; power producer; panel study; emerging markets; socially responsible investing.

Highlights:

- Different from previous studies – using data only from clean power producers
- Adding novel variables omitted in other studies: solar/wind, private/public dummies
- Solar power positively impacts performance: ROE is higher by 0.18 and ROA by 0.09
- Being a public vs. private clean energy producer decreases ROE by 0.09
- Sustainable power producers become more profitable than fossil fuel-based ones

Declarations of interest: none.

[1] Faculty of Economics and Sociology, University of Lodz, Lodz, Poland,
[*] Corresponding author: tomasz.schabek@uni.lodz.pl

List of abbreviations: ANOVA – analysis of variance, EBT – earnings before taxes, FE – fixed effects, LSDV – least squares dummy variable, NAICS – North American Industry Classification System, NRBV - natural-resource-based view, RE – random effects, ROA – return on assets, ROE – return on equity, SRI – socially responsible investing.

1. Introduction

The importance of sustainable development in the energy sector is clearly visible in the Renewable Energy Directive of the European Union [1], the United Nations Framework Convention on Climate Change, and similar trends in regulations worldwide. Such a shift towards new sources of energy has resulted in increased interest from financial analysts, investors, and policy-makers, as well as traditional power producers who are diversifying their revenues in line with these global trends. Technological progress and the growing efficiency of equipment used in the production of power from renewable energy is one aspect of these changes. The other equally important aspect is the financial efficiency of the power producers. In this study, the focus is oriented on examining the financial properties of "green energy" producers and distinguishing the factors that significantly influence the economic strength of the analyzed companies.

Briefly, the purpose of this study is to answer the following research question: What determines the financial profitability of sustainable power producers in emerging markets, considering their different legal forms and the types of renewable energy utilized? Our study introduces private companies into the analysis, focuses on producers that specialize only in renewable energy, and has a comprehensive sample of emerging market (EM) firms. Thus, the study adds to and verifies the results of previous studies and provides a comprehensive addition to the research of such an important part of today's economy as the sustainable energy sector. The topic of this study is important because: (1) it responds to the challenges and questions that arise from climate change by analyzing the relationship between sustainability and profitability. It also indicates that clean energy producers can achieve satisfactory financial results; (2) it takes into account the investors' point of view and gives insights into profitability in the context of socially responsible investing (SRI) in the renewable energy sector; (3) considering policy-making decisions, this research provides evidence that the sustainable energy industry, supported by political programs and reform, is not only environmentally, but also economically efficient[2].

Researchers who are inclined more towards finance and SRI studies can use the ideas presented in this paper to develop studies that link renewable energy with the financial and stock market investment performance of companies from this increasingly important sector. This study answers important questions like: "Does the legal form (private or public company) impact the financial performance of sustainable power producers?", "Does the type of renewable energy (solar vs. wind) impact this performance?" and "What is the financial profitability of sustainable energy producers compared to their fossil fuel-based counterparts?"

[2] A detailed analysis of the impact of such reforms can be found in Nepal et al. [6] and Jamasb et al. [7])

The rationale behind analyzing EMs is that they contribute greatly to the world economy, both in terms of Gross Domestic Product (GDP) as well as trade and population. According to the World Economic Outlook [2], almost 59% of the world's GDP, 36% of global exports, and 86% of the world's population come from emerging markets and developing economies. Also, emerging economies are proactively increasing the share of renewable energy in their energy mix (e.g. Sadorsky [3], Salim and Rafiq [4]). The latest study of Sharif et al. [5] shows that EM contribute to the reduction of environmental degradation.

Although the literature on the performance of sustainable energy companies is growing, there are no publications that address this issue in the context of emerging markets with both private and public companies. Similarly, there are no studies that differentiate producers that utilize solar or wind resources. In the existing literature, authors focus mostly on individual, developed countries and public companies, e.g., Australia [8], Canada [9], Japan [10, 11], Iceland [12], Spain [13], or the USA [14-17].

Some studies have analyzed groups of economies, however. Recently, Nepal, Jamasb and Tisdell [18] used panel data in order to analyze the impact of market reforms on CO2 emission for 28 developing economies. Ruggiero and Lehkonen [19] used panel data regressions for 66 companies from 26 countries, but only a few of them are EMs. Similarly, Gupta [20] analyzed 26 economies – most of them developed. Albertini's [21] meta-analysis included 52 different studies, but the majority of them focus on developed countries (mostly the US), and the period covered extends only to 2010.

Our research addresses the limitations of previous studies; thus, it makes a valuable contribution to the literature. In particular, we analyze the variables that describe the type of renewable resource used – solar vs. wind – and we distinguish between private and public companies. These aspects have so far been ignored in the literature. Another significant contribution is related to the focus on emerging markets and the long time series of the data. Finally, we provide evidence that by "being green," a sustainable power producer can be profitable, and the study discovers the determinants of this performance. We also provide evidence of recent financial performance by comparing sustainable producers with "traditional" (fossil-fuel based) ones. Other studies investigate companies that are not purely sustainable, and as our results indicate, this can impact the final conclusions.

We are motivated by the fact that the literature related to the topic of our study is scarce. While browsing the literature of the current state-of-the-art of the area, we found only a few publications that touch on this topic. This generally strengthens the validity of the objective of our study – to discover the factors that impact renewable energy producers and to close the gap in the literature. In the previous studies, we can identify a knowledge gap related to important variables being omitted, such as the type of renewable resource, or the legal form of the company. Current studies do not distinguish between the producers' different energy mixes (e.g., both renewable and fossil fuel sources used by the same company). This can strongly impact the results. Also, other studies focus mostly on developed markets, neglecting the growing importance of emerging markets. Summarizing, this study provides novel contributions to the existing literature in the following ways:

- It focuses only on a broad range of developing economies while discovering factors that shape the financial performance of renewable energy-based power producers.
- The article utilizes variables not analyzed in previous panel-data studies, i.e., solar and wind dummy variables, which describe the source of renewable energy, and private and public dummies which categorize companies into these two groups. This has a meaningful impact on the results presented in this research.
- The study covers a long period – from 2000 to 2017 – for both private and public companies.
- This article extends the scarce literature on SRI related to renewable energy and the natural-resource-based view (NRBV) in the context of renewable and sustainable energy.
- Finally, the article provides a comparison of profitability between sustainable power producers and fossil fuel-based ones.

The study is organized in the following manner: section two is devoted to the data and the methods used. Section three outlines and discusses the theoretical background with a brief literature review. Section four consists of the results, while a discussion with summarizing conclusions are in section five.

2. Data and methods

The framework of this analysis involves panel data regressions with fixed and random models. It is a standard approach when drawing conclusions from cross-sectional and time-series data (cf. studies of a similar nature: Marti-Ballester [22], Zhang et al. [23], Pätäri et al. [24]). Below we describe the type and source of the data and move on to explaining details of the panel data methodology and assumptions. In Figure 1, we present an overall framework of the data and methods.

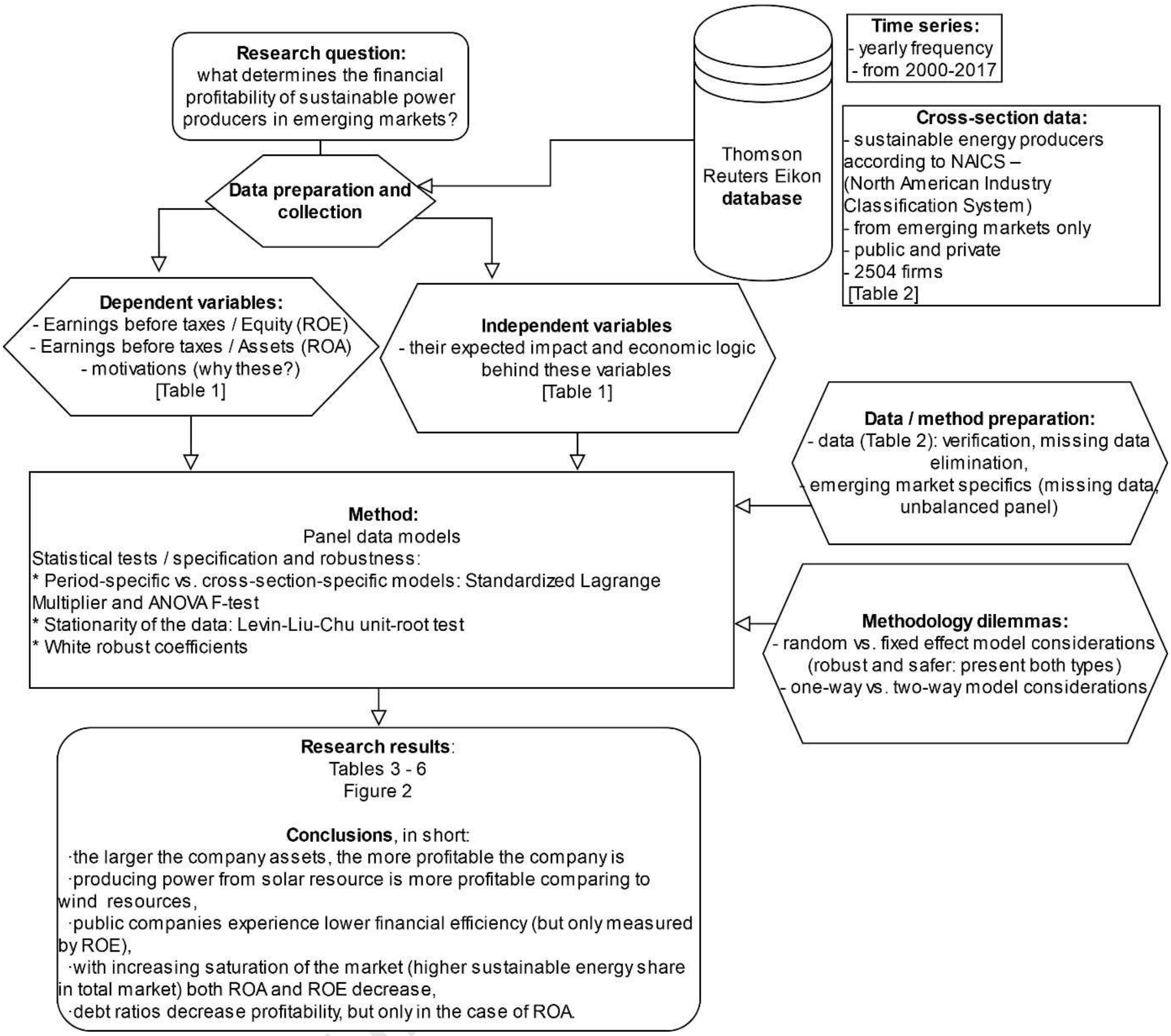

Figure 1. Data and methods framework

The financial performance of the analyzed companies in this study is measured using variables similar to return on assets (ROA) and return on equity (ROE) as the most natural and popular measures of the economic strength of firms in other studies, e.g Hart et al. [15], Ruggiero and Lehkonen [19], Aragón-Correa [25], Berrone and Gomez-Mejia [26], Earnhart and Lizal [27], Hamilton et al. [28]. We used earnings before taxes instead of net income in the nominator of ROA and ROE, as it eliminates the influence of a country's taxation system on the companies' performance. Nevertheless, we will use the symbols "ROE" and "ROA" for convenience. As we analyze both public and private firms (i.e., not listed on a stock exchange, including state-owned enterprises), other measures of performance based on market value (like Tobin's q or stock returns) are not used in this study. This is because it is not possible to produce Tobin's q or similar market-based indicators for private companies. The frequency of our data is yearly.

The independent variables used to explain the ROE or ROA variation are described in Table 1. There is a strong reason for most of these variables being selected as regressors as they have been used in similar types of studies. Company size is measured by the (natural logarithm of) total assets, as in other works [19, 29-31]. It is assumed that size will positively affect company performance as it helps to achieve economy of scale advantages over other companies, which is crucial in the power production business. The growth rate of the total revenues describes the demand for energy and revenue management efficiency, both of which have a positive impact on financial performance, cf. Iwata and Okada [10]. Capital investments are also expected to positively affect ROA and ROE as they increase the production potential of the firms. The debt to asset ratio reflects the risk of the company as higher leverage predisposes companies to a higher chance of bankruptcy. Also, this variable is expected to improve financial profitability – taking more risk should increase the expected return.

The renewable energy share in the market incorporates at least three pieces of information: (1) how effectively a given country supports sustainable investments (e.g., via subsidies, feed-in tariffs, or special government programs), (2) how the sustainable power market is growing, and (3) what the potential level of competition in the industry is. The first two aspects are positive for a firm's financial performance, but a higher level of competition has the opposite effect; therefore, it is hard to predict the coefficient sign. Two of the last three regressors presented in Table 1 take the form of dummy variables that categorize the firms into groups of solar-based or wind-based power producers.

It is hard to predict *ex-ante* precisely the impact that the type of renewable energy used will have on firm performance. However, based on a recent publication of the International Energy Agency [32], we suspect that in most OECD countries, the levelized cost of energy, used to compare different technologies of electric power production, is lower for onshore wind plants than for photovoltaic plants. The last dummy variable divides the companies into public and private ones (i.e., not listed on a stock exchange, and including state-owned enterprises). The literature on using this factor as a financial performance descriptor is scarce. Although some studies indicate that public companies perform better than private ones, e.g., for the textile industry in Poland Gajdka and Schabek [33], other articles suggest the opposite, Allee et al. [34] or provide mixed results, Coles et al. [35], Ke et al. [36].

Variable symbol	Description	Expected sign of the coefficient
ROA (EBT/A)	Dependent variable, earnings before taxes divided by total assets	N/A
ROE (EBT/E)	Dependent variable, earnings before taxes divided by equity	N/A
CAPINV	Natural logarithm of capital expenditures divided by total revenue	+
DA	Total debt divided by total assets	+
GROWTH	Rate of growth of total revenue in a given year	+
RESHARE	Electricity production from renewable sources, excluding hydroelectric (% of total) in a given year for the country of a given company. D(RESHARE,2) means the second difference of the RESHARE variable. Renewable energy market penetration.	+/-
TA	Size of the company measured as a natural logarithm of total assets	+

SOLAR	Dummy variable equal to 1 if the business description of the company includes words like “solar” or “photovoltaic” but does not include words like “wind,” “hydro” or “tidal,” 0 otherwise.	+/-
WIND	Dummy variable equal to 1 if the business description of the company includes words like “wind” but does not include words like “solar,” “photovoltaic,” “hydro” or “tidal,” 0 otherwise.	+/-
PUBLIC	Dummy variable equal to 1 if the company is listed on a stock exchange, 0 otherwise.	+/-

Table 1. Variables used in the study.

Notes: all variables are acquired from Thomson Reuters Eikon database, by selecting companies that are classified under the 2017 North American Industry Classification System (NAICS) code of 221119 “Other Electric Power Generation” (NAICS defines selected companies as “facilities [which] convert other forms of energy, such as solar, wind, or tidal power, into electrical energy”).

The Thomson Reuters Eikon database, from where most of the information about the companies was acquired, is the main source of data for this study. The Eikon database is widely used in many fields and has earned a reputation as being a reliable source of data. The databases of the IMF and World Bank were used to gather data on electricity production from renewable sources, excluding hydroelectric. Working with data for EMs needs special attention as, in many instances, the researcher might find it impossible to use them due to an incomplete time or cross-sectional series. In this study, longitudinal data regression (panel data regression) is used as the primary research method as it is most suited and is commonly used for this type of data, cf. Baltagi [37]. In a perfectly balanced panel (i.e., all 18 yearly observations available across times for all 2504 firms analyzed), we would have received a total of 45072 cross-sectional observations. Unfortunately, because of missing data, it was possible to use only a fraction of the whole population (298 firms regarding ROA and 282 regarding ROE from 16 emerging markets). In Table 2, the maximum number of observations available in the source database with the corresponding number of cross-sections (firms) is presented for each of the variables.

	ROA	ROE	CAPINV	DA	GROWTH	RESHARE	TA	SOLAR	WIND	PUBLIC
No. of observations	1,108	987	514	1,023	1,595	37,736	2,370	45,072	45,072	45,072
No. of cross-sections (firms)	298	282	54	191	513	2,494	554	2,504	2,504	2,504

Table 2. The number of analyzed sustainable energy-based power producers (cross-sections) and the total number of observations for each variable.

Notes: the number of observations is equal to the maximum of the product of the number of cross-sections (firms) and the number of periods (18 years). Because not all of the data are available in the database, we work with an unbalanced panel.

The selection of companies for the study is based on the North American Industry Classification System (NAICS), available in Thomson Reuters Eikon. The data were acquired for all available companies classified under the 2007 NAICS code of 221119, “Other Electric

Power Generation."[3] For the comparison of fossil fuel-based power producers, data under code 221112, "Fossil Fuel Electric Power Generation", are used.[4] A similar way of selecting firms for a sample was used in the study of Pätäri et al. [24], where the authors applied Standard Industrial Classification codes in order to extract energy producers.

We gathered data about 21 emerging market countries,[5] but for five of them (Chile, Colombia, Mexico, South Korea, and Taiwan) we were not able to acquire necessary data. Therefore, we excluded them from our sample. We selected this countries because of their growing importance in the world economy. The countries in our sample are characterized by relatively higher GDP growth compared to developed economies. However, it comes at a price of higher risk and volatility, such as with currency and the financial markets, but also foreign direct investments. Although GDP growth is higher, the levels of GDP per capita, financialization, and total wealth are much lower compared to developed countries. Nevertheless, EM economies are starting to play an important role in the global economy because of population growth and their internal potential to grow.

To give some perspective of recent trends in the sector, we also present a more straightforward, yet still useful comparison of both types of producers, "traditional" (fossil fuel-based) and sustainable. The sample of fossil fuel-based producers for this comparison contains available data on 316 companies (119 public and 197 not listed on the stock market). A comparison of the financial performance of fossil fuel and renewable energy-based electric power producers can be made by analyzing Tables 3 and 4.

The unbalanced panel data and the size of the analyzed economies brings one more important issue – companies from countries might have a higher share in the whole structure of the data. Indeed, this is true for the acquired data, but it was unavoidable. Most of the observations (in the case of ROE, as an example) come from the biggest economies: Brazil (36%), China (19%), India (12%) and Thailand (10%). For some of the countries, parts of the data were not available at all, so we had to exclude those observations from our sample. Therefore, from all of the acquired data, only a fraction can be used to assess the impact of the selected variables on financial performance. This is the biggest limitation of this study. The sample under analysis is characterized by an almost equal number of observations of listed (51%) and private companies, although some of the data are available only for public companies. Finally, the series of ROA and ROE were adjusted by removing those observations that take values above 0.50 (148 observations for ROE and 36 for ROA), in order to avoid bias in the results.

[3] The NAICS definition: "industry comprises establishments primarily engaged in operating electric power generation facilities (except hydroelectric, fossil fuel, nuclear). These facilities convert other forms of energy, such as solar, wind, or tidal power, into electrical energy. The electric energy produced in these establishments is provided to electric power transmission systems or to electric power distribution systems".

[4] The NAICS definition: "industry comprises establishments primarily engaged in operating fossil fuel-powered electric power generation facilities. These facilities use fossil fuels, such as coal, oil, or gas, in internal combustion or combustion turbine conventional steam process to produce electric energy. The electric energy produced in these establishments is provided to electric power transmission systems or to electric power distribution systems".

[5] Brazil, China, Colombia, the Czech Republic, Hungary, India, Indonesia, Malaysia, Mexico, Pakistan, Peru, the Philippines, Poland, Qatar, Russia, South Africa, South Korea, Taiwan, Thailand, and Turkey.

From Table 2, we can also see that the variable for capital investments (CAPINV) limits most of our sample – it has an impact on the total number of observations used in the regressions described in equation (1) below.

Because of the missing data, it is only possible to use unbalanced panel regressions in this study. The panel regression is the standard econometric technique used to draw conclusions from longitudinal observations, and was already used in similar studies. Fixed effects (FE) and random effects (RE) estimations are very often presented together in order to prove robustness and to compare the results of the estimates under different assumptions. In this study, following the same approach as in Ruggiero and Lehkonen [19], both FE and RE are utilized. For RE, the pooled estimated generalized least squares (EGLS) method is used. For FE, the pooled least squares method (least squares dummy variable – LSDV) is used.

The general (two-way) model of our panel regression can be expressed as in the following equation (cf. Baltagi [36]):

$$Y_{it} = \alpha_0 + \sum_{k=1}^{n} \beta_k X_{k,it} + \gamma_i + \delta_t + \varepsilon_{it} \qquad (1)$$

where: α_0 – the constant term, β_k – the coefficient related to the k-th explanatory variable, $X_{k,it}$ – the k-th explanatory variable, γ_i – individual-specific error term (effect), not dependent on time, δ_t – the time-specific error term (effect), not dependent on cross-sections, and ε_{it} – is the error term, denoting the rest of the disturbance. Subscript *i* denotes the individual company (cross-section), and subscript *t* stands for time.

In theory, we could allow the error terms γ_i or δ_t to vary across firms or periods, respectively. However, is not possible in our sample to allow a two-way error term model (i.e., with both the γ_i and δ_t terms in the estimated equation) due to the unbalanced data or singularities in the estimated matrixes if such a specification is applied. Therefore, we will conduct the analysis using only γ_i or only δ_t in (1), i.e., a one-way model. This leads us to the question – do we apply a structure of the model that includes period-specific or cross-section-specific error terms? To help select the proper structure of the model (period-specific vs. cross-section-specific), we used the Breusch-Pagan, Honda, and Standardized Lagrange Multiplier tests, (c.f. Baltagi [37], Moulton and Randolph [38]) for the RE model, and the ANOVA F-test and Chi-square test for the FE model.

The second issue is to decide what type of model to apply to account for the error term (γ_i or δ_t). If we assume that the error term can vary randomly (i.e. it is a random variable) and is independent of regressors ($X_{k,it}$) then the random effect model (RE) is more appropriate. If the error term is assumed to be a fixed parameter and possibly correlated with ($X_{k,it}$), then the FE would be a better choice, c.f. Baltagi [37]. However, the FE models suffer from losing degrees of freedom when estimated with the LSDV method. Additionally, the LSDV prevents us from including any variables in the model that are time invariant, c.f. Baltagi [37]. Therefore, it is not possible to estimate the FE model with the proposed dummy variables, which are naturally time invariant in our sample. Baltagi [37] and Green and Tukey [39] suggest that if the research focuses on a population (e.g., if the sample exhausts the population, or if the analyzed sample is interesting in itself for the researcher in such a way that for a particular analysis it can be seen as a population) then the FE model is appropriate. On the other hand, when we analyze a small sample of the population and want to infer conclusions about the whole population, the RE model is appropriate. In this study, by nature, we analyze only a small part of the total population, mostly because complete data are not available. In order to provide robustness of the results and to show how the assumptions of each model influence the results, both the FE and RE models are applied and presented in this study. This is because we are more interested in the direction of the influence of the independent variables on financial performance than the exact value of the coefficient.

Because our data have the structure of an unbalanced panel where the number of cross-sections (from 45 to 90, depending on the specification) is higher than the number of time-series observations (maximum 18 years) we applied the panel data model as the most appropriate model (c.f. [18]–[20], [22]–[24], [27]). Recently, Gupta [20] used different specifications but received relatively similar results from all of them. For unbalanced data, nonlinear models require rigorous assumptions, and with unbalanced data, unobserved heterogeneity cannot be totally eliminated. Additionally, missing observations prevent us from using these models. In the case of the data used in our study, we deal with missing observations (unbalanced panel). This is, however, unavoidable when studying emerging markets. Besides the comparisons related to fixed and random data models and one-way and two-ways models mentioned earlier, we applied additional, different methods of estimating the covariance structure. The methods that we applied are: the seemingly unrelated regressions (SUR) cross-section, and SUR- periods. The difference between these methods is that the SUR cross-section allows for conditional correlation between corresponding (in time) residuals for a cross-section, but assumes that the residuals in different periods are not correlated. Meanwhile, SUR-periods allows for serial correlation between residuals for the same cross-section, but does not allow correlation between different cross-sections. These methods did not provide different results than those presented by the White (cross-section) method. The advantage of the White standard error method is that it provides robust results that are not significantly different from other specifications. The main difference between the White method and the SUR method is that the residuals are replaced by moment estimators for the unconditional variances in SUR. In practice, we did not observe relevant differences in the results yielded by these methods. For brevity, we have not provided the results from the other specification, but they can be supplied on request.

We could not apply multiple time series regressions because the number of dependent variables is relatively high compared to the length of individual time-series (maximum of ten observations) and this would impair the level of the degree of freedom in the regressions. Also, the cross-sectional regressions would suffer from many missing observations and provide biased results. The same applies to dynamic models: firstly, we are more interested in a static framework; secondly, it is not possible to apply these models to all of the presented specifications, because for some variables only one observation of the cross-section can exist. This is natural for data describing emerging markets – for example, a given company can have an observation in a given year; then there is a break for the next year, and then there are data for subsequent periods. In such a case, we could not calculate the differences between the observations, nor could we apply the dynamic models. Therefore, we use a panel data model (fixed and random) as in similar studies. Advantages of using this method include (cf. Baltagi [37]: control for heterogeneity, provide more informative data, panel data give more degrees of freedom and less collinearity, panel regressions are better to analyse adjustment processes, they are better suited for testing more complicated behavioural models.

We applied the Hausman test to verify the specification of our equations. With non-rejection (p-value equal to 0.40 for ROA, and 0.33 for ROE regressions), we assume that the RE model (in which the regressors are assumed to be exogenous of the random individual effects) performs better as our main specification. Nevertheless, for robustness, we also provide the FE model results. Later on, we will see that the results are mostly similar for both the FE and RE models. All the variables in the study were tested for stationarity by the Levin-Lin-Chu test (c.f. Levin et al. [40]) and the presence of a unit root was found for one variable, namely the share of electricity production from renewable energy (RESHARE). Second difference was applied, and subsequently, RESHARE became stationary.

3. Theoretical background

Before approaching the topic of our study, we conducted a very thorough literature research. We were surprised that there are only a few related papers; thus, closing the gap in the literature was one of the motivations to conduct this study. We are not aware of other papers that would cover the same range, i.e. firm-level data from 16 emerging markets, or that introduce dummy variables like private/public companies or solar/wind type of energy for firms that produce power only from renewable sources.

The theoretical foundations of the studies related to the financial performance of sustainable, environmentally-friendly entities are presented in two different strands: The natural-resource-based view and socially responsible investing. The NRBV implies that sustainable companies can gain an advantage over non-green companies, and the performance of sustainable firms has been the subject of several studies. However, these studies usually concern developed economies and are not always energy-sector focused. Hart and Ahuja [15] used a sample of 500 U.S. firms to check if a reduction in pollution produced by these companies impacts their financial performance. They concluded that, usually, the marginal benefit from any reduction in pollution is lower than the marginal cost. Nevertheless, the biggest polluters can gain by reducing their pollution trace. King and Lenox [16] analyzed U.S. companies and concluded that it is generally worth “being green”, but the relationship between performance and sustainability is not obvious and depends on firm characteristics.

Gupta [20] analyzed alternative energy companies, but mostly from developed economies. Panel regressions were used to describe the excess return of alternative energy firms, but only publicly traded ones. The results indicate that growing prices of oil and technology stocks positively impact alternative energy stock returns. Aragón-Correa [25] discussed the relationship between business strategy and approaches to the natural environment in a sample of 105 Spanish firms. A proactive approach in the form of corrective and preventive measures was identified, with the conclusion that company size has an impact on the amount of training related to the environment. Ernhart and Lizal [27] used panel data of emerging-market companies from the Czech Republic for the period 1996-1998. They concluded that better pollution control neither improves nor undermines financial success. Most of these studies focused on the financial performance of firms regarding their decisions on sustainability. By contrast, our study focuses on the financial performance of emerging markets firms that produce power (only) from renewable resources. This distinguishes our analysis and adds value to the current literature.

The SRI literature suggests that market participants can invest in socially responsible instruments, not only for financial reasons but also moral ones. Such investments can also bring abnormal returns, c.f. Brzeszczyński et al. [41], who found that self-regulated companies in Poland are neither penalized nor rewarded for belonging to SRI index. The SRI literature often focuses on the performance of socially responsible companies (in a broad sense, not only environmentally), especially public ones. This is because it is much easier to use the market value to compare companies and indices when given explicitly, as indicated by Bohl et al. [42]. As such, diversified market indices are used in these kinds of studies, with little attention paid to specific sectors, like power production. Our study differs in this matter as we include private companies in our analysis.

Additionally, the SRI literature on emerging markets is much less developed than that related to advanced economies. A great number of SRI studies deal with developed markets, but as they provide insight into SRIs and evaluate SRI performance, none of them directly relates to the financial performance of clean power producers on emerging markets. Nakao et al. [11] investigated almost 300 firms listed in Japan. Their results indicate that ROA, earnings per share, and Tobin's q are positively influenced by a firm's environmental performance when measured by scores from the Nikkei Environmental Management Survey. Hamilton et al. [28] analyzed the performance of 17 U.S.-based socially responsible mutual funds and concluded that the characteristics of these funds are not priced by the market, i.e., investors do not lose or gain by investing in them. Lean et al. [43] investigated the performance of U.S and European SRI funds. Between 2001 and 2011, these funds outperformed the index, but the authors did not find strong evidence for the persistence of these rates of returns. Auer [44] generally confirms Hamilton et al.'s [28] results. Auer's findings also suggest that because of a loss of diversification, positive screens (adding SRI to a portfolio) can destroy a portfolio's value. Although Brzeszczyński and McIntosh [45] found that British SRI stocks perform better than general stock indices, their results were not statistically significant in the analyzed period of 2000-2010.

The topic of SRI has a much longer history in the U.S., with Moskowitz [46] introducing considerations about these kinds of investments in the early 1970s. The trend later appeared in Western Europe, as reported by Scholtens [47], when Denmark became one of the first countries to have a bank totally dedicated to SRI savings and loans. With the growing popularity of SRI, these kinds of investments also appeared in the mutual funds part of the capital market. Statman [48] analyzed these funds using the Domini Social Index, and found that they do not perform worse than the average non-SRI mutual fund. Syed [49] presented very similar conclusions, but regarding UK and French stocks. Yu et al. [50] analyzed a large group of firms across 47 developed and emerging economies. Their results indicate that for companies exercising environmental, social, and governance (ESG) transparency, financial performance measured by Tobin's q increases. The results of a recent study by Brzeszczyński et al. [51], which focused on companies representing the energy and resources sectors, indicate that SRI indices, especially from the Alternative Energy and Gas sector, are among the best performers, with annual rates of return equal to 9.44%. However, 16 of the 19 countries in that study are developed economies. These results underline the need to investigate the performance of renewable energy sectors, especially from emerging markets.

Studies that focus specifically on SRI in emerging markets are relatively scarce, although their number has started to grow. In recent years, for example, there have been some studies related to emerging markets. Adamska et al. [52] indicated that post-communist countries are far behind developed economies in the creation of SRI funds, suggesting that weaker financial development can be the cause of such disproportion. Brzeszczyński et al. [53] indicated that SRI stocks are relatively less risky (measured by the beta parameter) and perform surprisingly well on the Polish stock market. Using the Polish energy market as an example, Janik [54] described the challenges that coal-dependent economies encounter. Janik and Bartkowiak [55] compared the SRI indices in Poland and Austria. They concluded that the process of selecting companies to be a member of the index is different in these markets and it impacts the risk-return properties of portfolios.

Erragragui et al. [56] analyzed the ethical aspects of SRI in developed economies and three emerging markets (Brazil, India, and South Africa). They concluded that investing in ethical indices can yield abnormal returns, especially in times of a market downturn. Sonnenberg and Hamann [57] reported on the development of SRI in South Africa, concluding that that there is an improvement in the scope and depth of coverage of sustainability reports provided by South African companies. They also concluded that only a few reports include quantitative data and third-party verification. Mandelli et al. [58] provided a review of sustainable energy in African countries. They indicate that a lack of coordination with other challenges in African economies and the fragmentation of policies are the most important problems in the development of sustainable energy in Africa.

Chelawat and Trivedi [59] studied the impact of SRI screening on investment performance in India. They concluded that SRI-screened stock portfolios bring higher returns compared to benchmark, but their study does not consider size or price-to-book value factors. Sudha [60] also analyzed the Indian stock market and presented conclusions similar to Chelawat and Trivedi's. However, she underlined that there is asymmetry in the volatility of SRI indices. Also analyzing SRI in India, Tripathi and Bhandari [61] concluded that investors are not penalized for investing in ethical or socially responsible assets. These findings are similar to results of many studies from developed market. But again, these studies do not focus on the energy sector.

He et al. [62] investigated 141 Chinese renewable energy companies and the indirect effects of bank credit on this sector. They indicated that renewable energy firms lower the amount of loans when there is an increase in their green financial development. Chang et al. [63] analyzed a cross-section of 35 publicly trade Chinese companies from renewable industry between 2010-2017. They investigate total investment efficiency, pure technical efficiency and scale efficiency. They conclude that support to the industry (like tax rebates or subsidies) have positive and significant impact on all three types of efficiency measured.

Martí-Ballester [64] asked if renewable energy mutual funds help to switch to a low-carbon economy. The results suggest that these mutual funds yield similar returns to the market benchmark but underperform when a specialized benchmark is used. Additionally, size and SRI certification do not affect their excess returns. Ibarloza et al. [65] investigated the financial performance of Spanish photovoltaic energy producers. They concluded that although the sector of renewable (solar-base) energy producers was profitable, after the financial crisis of 2008, the cost of debt was too high to allow it to develop, especially with tightening financing conditions. Therefore, investments in new photovoltaic plans significantly decreased in Spain.

Shimbar and Ebrahimi [66] assed political risk in the context of evaluating renewable energy investments using a case study of Iran’s developing economy. They introduced a modification to the classical risk evaluation model and concluded that the altered version, which included political risk factors, may yield different (and positive) results compared to classical methods.

Publications that utilized panel data from more than one EM and that draw conclusions regarding renewable energy and financial performance are scarce. By conducting our research for a specific sector (electric power producers), which is important in the context of recent environmental challenges, we fill this gap in the literature. To the best of our knowledge, this is the first study that uses longitudinal data on the profitability of sustainable energy producers for both private and public companies solely from emerging markets and with dummy variables representing solar and wind resources.

The literature that relates to financial performance and involves company-level panel data on producers from different EM countries is even less common. A few examples of panel studies that relate to our topic are mentioned below. In our study, we use the well-established methodology of panel regression, as in other studies, e.g., Nepal, Jamasb and Tisdell [18], who applied it when analyzing the impact of economic reforms on CO_2 emissions. They discovered that the main forces that helped to reduce CO_2 emission come from the economic e□ciencies that result from market reforms. Recently, Ruggiero and Lehkonen [19] applied panel data linear regression to measure the impact of using sustainable energy by 66 large electric companies. Their main results indicate that an increase in renewable energy penetration has a negative impact on financial performance (FP), an increase in debt ratio decreases FP, and size has a positive influence on FP. We have validated and confirmed these results, but we introduced new important variables that had not been investigated previously. This allowed us to deepen and extend Ruggiero and Lehkonen's findings.

We utilized similar control variables, but our study differs significantly from the latest literature in several important aspects. Firstly, we do not analyze companies from advanced markets – we study only emerging market companies. The total number of companies in our dataset is 2504, although the majority of them have missing data. Nevertheless, we utilized between 45 and 90 firms (depending on the regression specification) in our regressions, which is a large number, relative to other studies. Secondly, the most recent studies did not consider private companies. This inclusion is particularly important, as non-stock exchange-quoted firms may have different properties than public ones, and this significantly impact the results. The third important distinction is that previous studies focused on firms that do not specialize solely in the production of green energy but that might produce it as part of their (energy) mix of renewable and fossil resources (e.g., a traditional coal-fueled company that also produces some of its energy from a renewable source).

Therefore, previous results (e.g., the negative impact of debt ratio or renewable energy production on financial performance, as reported by Ruggiero and Lehkonen [19]) could be the effect of these firms not specializing. Also, it implies that they can use resources in activities in which they do not have advantages (e.g., know-how or experienced human capital). Companies can do this because of regulations that penalize for production only from fossil-fuels or that are directly enforced by legal obligations, for example. Alternatively, there may be government incentives to produce a certain amount of energy from renewable resources.

In our study, we selected companies that are classified as "other electric power generation." Acknowledging that some companies may also use fossil fuels as part of their business, we believe that the North American Industry Classification System is a valid source of information. It clearly distinguishes between types of producer and is used by US federal statistical agencies. This leads us to an interesting question for future research: what would the relationship between renewable energy production and financial performance look like if it were tested for companies that specialized only (or mostly) in clean energy production? Unfortunately, due to data limitations, we were not able to directly investigate this, but it leaves room for future research. Our results validate Ruggiero and Lehkonen's [19] outcomes related to the relationship between selected independent variables but for a larger number of renewable energy producers from emerging markets. Finally, our study incorporates new variables that introduce new information: the legal form and the type of resource used (solar vs. wind).

Other recent examples where a panel regression was applied include the works of Marti-Ballester [22], Zhang et al. [23], and Pätäri et al. [24]. Martí-Ballester [22] applied a panel data model for a large sample of multinational companies and investigated if implementing sustainable energy systems has an impact on financial performance. They found that using renewable energy systems does not statistically impact the financial performance of the analyzed companies. Of course, our study differs from Martí-Ballester [22], as we analyze power producers (the supply side) as opposed to consumers (the demand side).

Zhang et al. [23] provided insights into the relationship between renewable energy producers in China, their political connections, and the subsidies they receive from the government. In their panel data models, they describe ROA for wind and solar energy producers using dummy variables to represent managers' political connections, government subsidies, and control variables like capital intensity and the proportion of the largest shareholders in total shares. They concluded that subsidies have a positive and significant impact on financial performance, but the political connection impairs it. These results apply to the whole group of companies, both wind and solar, but surprisingly, they are not significant if only solar-based companies are analyzed.

As in our study, Pätäri et al. [24] utilized panel data in their research. They concluded that corporate social responsibility (CSR) influences the market capitalization of energy-sector companies, but changes in CSR concerns have a delayed impact on ROA. However, they used a small sample (14 firms) of public companies and did not focus on emerging markets. Also, they tested the effects of overall CSR on financial performance, whereas we assess companies' financial characteristics (like debt and assets) together with their legal form and type of energy used. While they studied energy-sector firms (most of which are "traditional," fossil fuel-based companies from advanced economies), we study only renewable companies from emerging markets..

Brzeszczyński et al. [51] analyzed the stock market performance of publicly-quoted companies from the energy and resource sectors that are classified as socially responsible investments (SRI). They found that changes in the price of crude oil have a stronger impact on the performance of oil-related stocks compared to non-oil related stocks. This result may suggest that non-oil-based energy companies can serve as a hedge (protection) against the inflation of oil prices. This underlines even more the importance of studying the performance of sustainable companies. They emphasized that their study refers mostly to developed economies, and there is a need for similar research on emerging markets.

4. Results

Before moving to the panel data model, we briefly compare the data for last five years between fossil fuel ("traditional") power producers and renewable energy-based producers, which can shed some light on the current state of the energy industry in emerging markets. For both types of producers, we notice that listed companies were more efficient than private ones. However, this difference is getting smaller with time, and in some years, private companies performed better than public ones. The share of listed entities in the total revenues for renewable energy-based producers is much smaller (in the whole period: 48%) and has declined over time, while for "traditional" producers, it is stable and at a high level of 93%. This, combined with the rapid increase in the number of private companies in the "renewables" segment of the market, shows how dynamic the renewable energy part of the market is compared to "traditional" producers.

Generally, we observed that during the period 2013-2017, traditional producers performed better. However, with time, there was a strong trend among the renewable producers to increase productivity: EBT/E (earnings before taxes/equity) grew from 2% to 15% while for fossil fuel-based producers, the EBT/E decreased from 14% in 2013 to 9% in 2017. Such a change might have been caused by the increased efficiency of the equipment used in renewable production and the higher cost of CO2 emission rights borne by traditional producers. It is important to remember that the data presented in Tables 3 and 4 show the characteristics of the whole industry[6], i.e., aggregated indicators. For example, EBT/E (ROE) for 2015 ("renewable" public and private power producers) is calculated as the sum of earnings before taxes of all 137 companies divided by the sum of the equity for all these firms, while in the panel regressions, our dependent variables are the individual ratios of EBT/E (ROE) and EBT/A (ROA). Figure 2 provides a direct comparison between fossil fuel and renewable energy producers in terms of ROE and the development of the number of companies in the market. It allows us to see clearly the recent drastic improvement in financial performance despite growing competition among sustainable power producers.

	2013	2014	2015	2016	2017	2013-2017
Renewable - public & private						
ROE (EBT/E)	2%	11%	8%	11%	15%	10%
EBT/S	2%	9%	7%	10%	12%	8%
S/A	0.31	0.29	0.29	0.28	0.37	0.31
A/E	3.27	4.25	3.94	3.92	3.55	3.76
PUBLIC	57%	54%	50%	47%	37%	48%
Renewable - public						
ROE (EBT/E)	11%	13%	9%	12%	13%	12%
EBT/S	9%	12%	8%	13%	16%	12%
S/A	0.33	0.29	0.27	0.25	0.25	0.28
A/E	3.60	3.77	3.75	3.56	3.31	3.58
Renewable - private						
ROE (EBT/E)	-6%	9%	7%	10%	18%	7%
EBT/S	-7%	6%	5%	7%	9%	5%
S/A	0.29	0.29	0.31	0.30	0.51	0.34
A/E	2.95	5.01	4.17	4.39	3.90	3.99

Table 3. Performance of renewable energy-based electric power producers, 2013-2017.
Notes: the row titled "public" presents the share of total sector revenues assigned to listed companies. EBT – earnings before taxes, E – equity, S – sales, A – assets.

The main trends in both Tables 3 and 4 show an increase in profitability for sustainable producers and a decrease for fossil fuel-based ones. This is driven by all three financial ratios presented in Tables 3 and 4. Renewable producers experience an increase in gross profit margin (EBT/S) from 2% to 12%. Meanwhile, non-sustainable producers recorded a decrease

[6] Therefore, they are not comparable with the results of the panel regressions.

from 11% to 8%. Renewable producers were able to increase asset turnover (S/A) from 0.31 to 0.37 and increase leverage (A/E). All of these positive changes go along with increased competition, measured by the total numbers of companies. Overall, as shown in Figure 2, the financial performance of sustainable producers has increased in recent years, in contrast to traditional power producers. In the next part, we will discover the main variables that determine this performance.

	2013	2014	2015	2016	2017	2013-2017
Fossil - public & private						
ROE (EBT/E)	14%	14%	13%	8%	9%	12%
EBT/S	11%	11%	12%	8%	8%	10%
S/A	0.39	0.37	0.34	0.33	0.35	0.36
A/E	3.15	3.27	3.16	3.20	3.18	3.19
PUBLIC	94%	93%	92%	94%	93%	93%
Fossil - public						
ROE (EBT/E)	15%	14%	14%	8%	9%	12%
EBT/S	12%	12%	13%	7%	8%	11%
S/A	0.39	0.35	0.33	0.32	0.34	0.35
A/E	3.18	3.35	3.26	3.27	3.24	3.26
Fossil - private						
ROE (EBT/E)	0%	5%	3%	11%	8%	6%
EBT/S	0%	3%	3%	12%	8%	5%
S/A	0.50	0.69	0.61	0.38	0.43	0.51
A/E	2.69	2.01	1.99	2.42	2.34	2.28

Table 4. Performance of fossil fuel energy-based electric power producers, 2013-2017.

Notes: the row titled "public" presents the share of total sector revenues assigned to listed companies. EBT – earnings before taxes, E – equity, S – sales, A – assets.

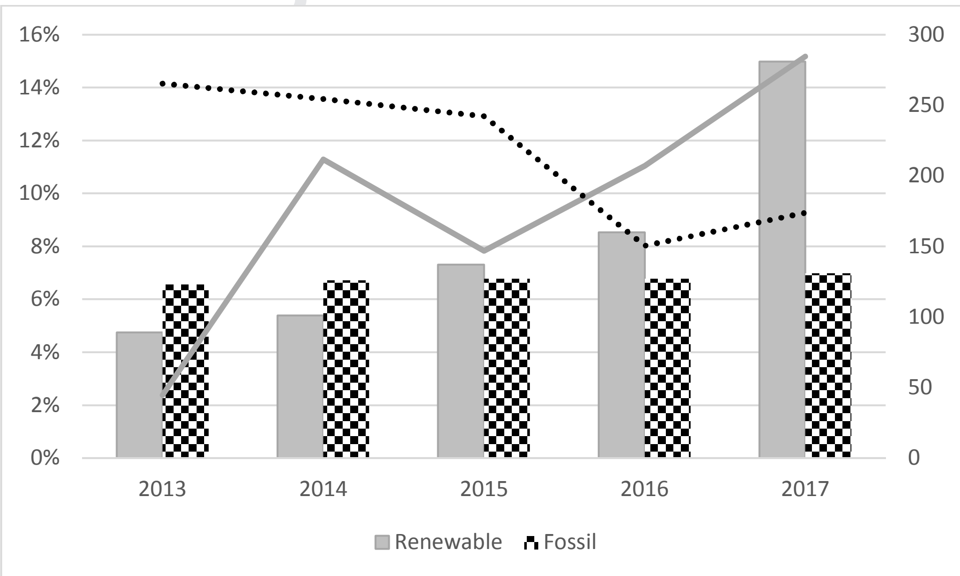

Figure 2. Financial performance and number of companies in recent years.

Notes: columns (right axis) indicate the number of companies by each type of producer; lines (left axis) present the return on equity.

The formal panel regression models provide more insight into the factors that shape the financial efficiency of individual renewable electric power producers. Using standardized Lagrange multiplier tests for RE, we rejected the null hypothesis that there are no cross-sectional effects. However, we were unable to reject a similar hypothesis regarding the period effects. The F-test and Chi-square test for FE produced similar results. Therefore, the time-specific error term (δ_t) was removed from the general model presented in equation (1). The cross-sectional RE and FE model estimations for ROE and ROA are presented in Tables 5 and 6.

The outcomes of our analysis, presented in Tables 5 and 6, are in line with the results of a recent study by Ruggiero and Lehkonen [19], which was conducted using a similar methodology, but mostly for developed countries. However, there are significant differences, notably the impact of debt on performance. The debt to assets ratio with a negative coefficient indicates that, in the short term, taking on more debt decreases performance. Interestingly, this does not apply to ROE, indicating that higher debt does not necessarily impair performance in the eyes of the (equity) owners. In all but one of the model specifications, the size of the company (measured by total assets) positively influences performance (for both ROE and ROA), which implies that being a larger company in the electric power industry helps to achieve better financial results. One of the most interesting results not reported in other studies shows that firms that mainly produce electric power using solar energy are more efficient than the rest of the analyzed companies.

	1		2		3		4	
	RE		RE		RE		FE	
	Coefficient	p-val	Coefficient	p-val	Coefficient	p-val	Coefficient	p-val
CAPINV	0.00	0.83	-	-	0.00	0.97	0.00	0.85
DA	-0.06	0.26	-0.02	0.39	-0.03	0.46	-0.08	0.18
GROWTH	0.00	0.40	0.00	0.71	0.00	0.43	0.00	0.23
D(RESHARE,2)	-0.01*	0.06	-0.01**	0.02	-0.02**	0.04	-0.02	0.19
TA	0.02***	0.01	0.01***	0.00	0.02**	0.01	0.04**	0.05
TIME	-0.01***	0.00	-0.01***	0.00	-0.007***	0.00	-0.01***	0.00
SOLAR	0.18**	0.03	0.14	0.10	-	-	-	-
WIND	0.04	0.11	0.02	0.32	-	-	-	-
PUBLIC	-	-	-0.09***	0.00	-	-	-	-
Const.	-0.30*	0.05	-0.01	0.88	-0.17	0.18	-0.52	0.12
No. of obs.	299		373		299		299	
No. of cross-sections	45		82		45		45	

Table 5. Estimations of panel regression coefficients for ROE

Notes: ***, **, * - estimates statistically significant at 0.01, 0.05 and 0.10 p-value levels. RE and FE mean random effects and fixed effects, respectively. Robustness: White robust coefficients are presented, standard coefficients are available upon request, but they did not change significantly from those presented. The specifications presented in Tables 5 and 6 represent comparable random and fixed models (columns 3 and 4). In columns 1 and 2, we present only the random models, as a fixed effect model cannot be created for time-invariant variables (our dummies). Because of the data composition (capital investment data are available only for public companies), we ran regressions with different specifications, as presented in columns 1 and 2. Column 1 represents only public companies (as in columns 3 and 4), whereas the results in column 2 reveal the significant factors for a wider available set of companies (and observations): public and private.

Wind energy-based producers do not seem to gain additional efficiency, although when we consider the public companies dummy, the “solar” dummy is no longer significant (p-value slightly above 0.10). Lower efficiency is observed for listed firms, as the coefficient of the “public” dummy remains negative for ROE. As these variables have not yet been tested in the literature, they add an important contribution to the field. However, at the same time, we could not compare the sign of the estimated parameters with the results of other studies. The second difference of the share of electricity production marked as D(RESHARE,2), significantly influences the ROE and ROA. In both cases, the coefficient is negative, which would suggest that the more saturated the market, the lower the financial performance of the analyzed firms, *ceteris paribus*. In the next part, we will discuss the results in greater detail. Briefly summarizing main points derived from Tables 5 and 6, we notice that:

- the greater the company’s assets, the more profitable the company is confirming results of previous studies,
- producing solar energy is more profitable compared to wind energy,
- public companies experience lower financial efficiency (but only measured by ROE),
- with increasing saturation of the market (a higher sustainable energy share in the total market), both ROA and ROE decrease,
- debt ratios decrease profitability, but only in the case of ROA.

	1		2		3		4	
	RE		RE		RE		FE	
	Coefficient	p-val	Coefficient	p-val	Coefficient	p-val	Coefficient	p-val
CAPINV	0.00	0.99	-	-	0.001	0.90	0.00	0.87
DA	-0.11***	0.00	-0.01	0.84	-0.10***	0.00	-0.14***	0.00
GROWTH	0.00	0.26	-0.001*	0.09	-0.001	0.16	0.00	0.34
D(RESHARE,2)	-0.01**	0.03	-0.01***	0.00	-0.01***	0.00	-0.01**	0.02
TA	0.01***	0.00	0.00	0.56	0.01**	0.03	0.02*	0.05
TIME	0.00	0.18	0.00	0.24	0.00	0.31	0.00	0.15
SOLAR	0.09***	0.01	0.04	0.35	-	-	-	-
WIND	0.03	0.24	0.00	0.95	-	-	-	-
PUBLIC	-	-	-0.03	0.17	-	-	-	-
Const.	-0.15**	0.05	0.11*	0.08	-0.08	0.27	-0.29	0.11
No. of obs.	325		412		325		325	
No. of cross-sections	45		90		45		45	

Table 6. Estimations of panel regression coefficients for ROA

Notes: ***, **, * - estimates statistically significant at 0.01, 0.05 and 0.10 p-value levels. RE and FE mean random effects and fixed effects, respectively. Robustness: White robust coefficients are presented, standard coefficients are available upon request, but they did not change significantly from those presented. The specifications presented in Tables 5 and 6 represent comparable random and fixed models (columns 3 and 4). In columns 1 and 2, we present only the random models, as a fixed effect model cannot be created for time-invariant variables (our dummies). Because of the data composition (capital investment data are available only for public companies), we ran regressions with different specifications, as presented in columns 1 and 2. Column 1 represents only public companies (as in columns 3 and 4), whereas the results in column 2 reveal the significant factors for a wider available set of companies (and observations): public and private.

5. Discussion and conclusions

In this research, we found variables describing the financial performance of sustainable power producers from emerging markets (EM). This study adds novel results to the current state of the art because: (1) our results include new important variables (solar- or wind-based producers), (2) we avoid the limitations of previous studies in which the analyzed companies produced a mix of fossil fuel and clean energy products – this impacts robustness of the results; (3) we analyzed both public and private companies, and (4) we studied important and growing economies from emerging markets (EM) over a long period (2000-2017).

We applied a set of panel data regressions in order to identify relevant variables. This method is used in most previous studies and matches the longitudinal character of the data. We introduced fixed and random effects, and in order to provide further robustness, we used a battery of statistical tests in our models. The initial results of the study are listed below. The last three conclusions deserve broader discussion, which follows later.

- Generally, in recent years, renewable energy producers have improved their financial performance compared to fossil fuel producers (Table 1).
- Return on equity (ROE) and return on assets (ROA) are positively impacted by the size of the company. This confirms previous findings.
- Using solar energy generally increases ROE by 0.18 and ROA by 0.09. By contrast, wind-based power production does not have a statistically significant effect on performance.
- The share of electric energy from renewable sources has a negative impact on financial performance (ROA and ROE decrease by 0.01).
- Public companies seem to have lower ROE (by 0.09), but ROA is not affected by the legal status.
- The level of debt (which could be a measure of risk) impacts ROA but not ROE.

In contrast to other studies, we focused exclusively on EM and only on sustainable energy producers. Moreover, we introduced novel variables not explored previously, i.e., the type of renewable resource used to produce energy (solar vs. wind) and the legal form of the companies (private vs. public). For this reason, our conclusions can also be extended to private companies. This approach and our results indicate that different sets of variables can play an important role in explaining financial performance, depending on how we measure this performance.

In the case of ROA (earnings before taxes/total assets), the debt to asset ratio significantly decreases short-term performance, whereas, in the case of ROE (earnings before taxes/equity), such an effect does not exist. One interpretation can lead to the conclusion that because performance increases when companies increase their assets (total assets significantly and positively impact both ROE and ROA), firms probably take on more debt to finance new assets, leading to higher interest expenses decreasing earnings. These decreased earnings, in relation to higher total assets, cause a lower ROA ratio, but they do not have a great impact on ROE as equity did not increase (it might even decrease in the case of an accounting loss).

Why is such a mechanism visible in the case of renewable energy producers? Sustainable power production demands technologically advanced equipment, which usually becomes obsolete much faster than in traditional sectors. This can explain why, in Ruggiero and Lehkonen's [19] study, both ROA and ROE decrease as the debt to asset ratio increases. Firstly, the firms in their study do not represent only renewable producers, so the firms' equipment is more probably "technology-resistant" in the sense that there is a mix of renewable and traditional (fossil-fuel) assets that have a different economic life expectancy (depreciation). Secondly, if the analyzed companies are quoted on the stock market (public companies), it allows them to finance assets by increasing equity in a relatively faster and easier way. If such assets start to become obsolete and generate less profit, it is also visible in ROE, as lower profits are now divided by higher equity.

This study provides comprehensive results that differ from other investigations, and it contributes to the literature because we also used data from private companies. These results should attract more attention for future research in the area of the profitability of renewable energy producers, especially including private companies in the analyzed sample; thus, we encourage other authors to develop this topic. It also raises interesting possibilities for future studies in this area, e.g., what would the relationship be like between renewable energy production and financial performance if it were tested for companies that specialized only (or mostly) in clean energy production? Ruggiero and Lehkonen's results [19] suggest that this relationship is negative, but it should take into account the companies' specialization. Perhaps researching companies that produce energy which is characterized by, e.g., an 80% (renewable) and 20% (fossil-fuel) mix would bring completely different results than firms with, e.g., a 20% (renewable) / 80% (fossil-fuel) structure.

The conclusions drawn from the results presented here indicate that the most important "standard" factors that shape the short-term financial performance (measured by both ROA and ROE) of renewable electric power producers from emerging markets are the size (total assets), debt, and market penetration. New variables that significantly impact financial performance include dummies representing the type of renewable energy used (solar/wind) and the legal form (public, listed companies). Both analyzed variables (ROA and ROE) are described by a slightly different set of explanatory variables. In the case of both ROA and ROE, the "renewables" penetration of the market has a significant and negative coefficient. This is partially expected and natural – as mentioned previously, market saturation contains at least three pieces of information: (1) how efficiently governments support sustainable investments (the effect is generally long-term and positive), (2) how fast clean energy production is growing (an ambiguous effect on performance), and what seems to be the most important, (3) what the level of competition is on the market.

Our results indicate that greater competition has a negative impact on short-term financial performance. This is an important conclusion in the context of political decisions when it comes to supporting new companies entering the renewable energy market. The last important conclusion from the study indicates that although sustainable electric power producers (as a whole sector) experienced lower financial efficiency in the 2013-2017 period, recent years have brought a significant increase in financial indicators for renewable energy-based producers and a decrease for producers using fossil fuels. This outcome is in line with the results of a recent study by Brzeszczyński et al. [51] that examined the performance of SRI companies that represent energy sectors in developed economies. The growing number of firms in the sustainable part of the electric power sector (from 89 in 2013 to 281 in 2017) suggests that it is becoming more and more profitable to deliver electric power in a cleaner and more sustainable way.

Naturally, our study has certain limitations, in particular, unbalanced panel data with the dominance of larger economies (Brazil and China) and a general lack of available data. This is especially visible when emerging markets are the subject of analysis. Nevertheless, these obstacles are hard to avoid. We focused on short-term performance and leave long-term-based studies for future research as data become more available. Measuring the direct impact of the production of (only) renewable power vs. the possibly higher marginal cost of sourcing renewable energy, especially via non-centralized, individual systems, is another challenging research topic where sustainability and the financial performance of the system can be investigated.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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