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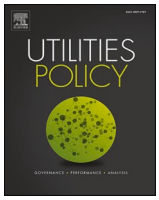

Full-length article

Do ESG factors improve utilities corporate efficiency and reduce the risk perceived by credit lending institutions? An empirical analysis

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ABSTRACT

In a changed scenario, characterized by great attention to environmental, social, and governance (ESG) factors, few industries feel the pressure more than utilities. The paper investigates, by employing a Data Envelopment Analysis (DEA) model, whether including ESG factors increases the efficiency of utilities companies and whether banks, by considering ESG ratings when selecting utilities companies, succeed in optimizing their portfolio. Our findings signal that ESG factors neither improve utilities efficiency nor constitute a useful complementary criterion for credit lending managers, provide useful suggestions for managers, regulators and academics.

1. Introduction

In today's world business environment, traditional accounting practices focused only on the financial results of business activities fail to meet the requirements of organizational stakeholders (Gurol and Lagasio, 2021). Institutional investors, rating agencies and customers ask companies for reporting on corporate environmental, social and governance (ESG) performance. In some institutional contexts, like Europe, disclosing non-financial information (NFI) has been mandatorily requested to public interest entities (PIEs).[1]

In this changed scenario, characterized by great attention to ESG factors, few industries feel the pressure more than utilities. Utilities are private, for-profit companies belonging to the public service infrastructure which play a vital role in society providing critical infrastructure services that every individual is dependent on nowadays (Khalid et al., 2021); they typically pursue social purposes aimed to achieve public value creation, nevertheless their operations could cause negative externalities to local communities (García Meca and Martínez Ferrero, 2021). For these reasons, it is not surprising that utilities companies are subject to particular attention and pressure from customers and the community and that a very strong regulatory framework protects and governs the sector (Mio, 2010; Valenza and Damiano, 2023; Venturelli et al., 2023).

Disclosing ESG information could be a strategy to gain legitimacy by increasing the quality of ESG disclosed information, to address stakeholders' expectations and contribute to the achievement of strong, sustainable, balanced and inclusive growth through supporting the Sustainable Development Goals (SDGs), and utilities managers have widely adopted innovative communication tools, conducted effective sustainable initiatives on a voluntary or mandatory basis and contributed to the development of best practices (Imperiale et al., 2023). On the other hand, disclosing ESG information could be a strategy to repair the loss of legitimacy caused by adverse and unexpected events or scandals (Corazza et al., 2020), and to manage reputational risk (the risk that the disclosure of unfavorable information can lead to an unfavorable perception of the industry). Empirical literature provide evidence that

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[1] In the literature there is a considerable debate on the terms non-financial information (NFI), corporate social responsibility (CSR), environmental, social and governance (ESG). In this article we share the vision according to which NFI is an umbrella term including concepts such as CSR and ESG (Tarquinio and Posadas, 2020). As regards the difference between CSR and ESG, CSR is about providing accountability within the organization and is theoretically rooted in the stakeholder theory, while ESG aims to collect and measure relevant items for business and stakeholders and can be considered the evolution of the CSR concept, since it specifies three core typologies of stakeholder-firm relationships: environmental, social and governance (Khalid et al., 2021; La Torre et al., 2021).

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utilities companies involved in scandals have widely adopted greenwashing mechanisms and impression management strategies (Cong et al., 2020; Goloshchapova et al., 2019). Furthermore, the conflicting findings (no association, positive association, negative association) provided by empirical research, and the strong call of industry-specific research (Kaupke and zu Knyphausen-Aufseß, 2022; Pacelli et al., 2022) drove us to investigate whether ESG factors improve the overall efficiency of utilities companies.

Regarding the association between ESG and financial performance, it is also ever more important for credit institutions, which are requested to integrate ESG factors into their credit risk assessment, to contribute to creating sustainable lending whilst improving their performance and reducing their credit risk (Brogi et al., 2022).

This paper aims to investigate firstly whether including ESG factors in calculating the corporate efficiency of utilities companies increases their performance, also mitigating their exposure to the default probability, and secondly whether banks, selecting utilities companies on the basis also of ESG ratings, mitigate their credit risk and improve their performance.

Our article is original as it focuses on the association between ESG and financial performance of a specific industry (utilities) barely investigated (Şeker and Güngör, 2022; Imperiale et al., 2023) and because it chooses to focus on corporate efficiency as a measure of corporate performance, calculated through Data Envelopment Analysis (DEA). DEA, switching the focus from a causal association between ESG and financial performance to a perspective of inputs and outputs, allowing the readers to truly understand the differences in the efficiency of a company's input resources in terms of overall (ESG and financial) performance (Lu et al., 2023).

To the best of our knowledge, in the extant literature there are no studies using a DEA-approach to investigate whether including ESG factors improves the corporate efficiency score of companies, and reduces the risk and improves performance for financing credit institutions.

The contributions of our paper are manifold. First, it addresses the need for more industry-specific analyses pointed out by several authors (Pacelli et al., 2022; Kaupke and zu Knyphausen-Aufseß, 2022), focusing on the utilities sector, a controversial and environmentally sensitive sector, scarcely investigated in the empirical literature (Venturelli et al., 2023). Second, this paper considers European listed utilities instead of focusing on USA utilities, so considering an institutional context characterized by non-financial regulation (Valenza and Damiano, 2023). Thirdly, considering multiple input and output indicators to estimate the overall efficiency of utility firms through a DEA-based approach, it produces a benchmark of the utilities industry, which less-effective firms can refer to, to improve their overall performance. Fourthly, the study sheds light on how ESG performance affects utilities companies' performance and the creditworthiness assessment of credit lending institutions.

The paper is organized as follows: Section 1 introduces the topic; Section 2 presents the literature review and the research questions development; Section 3 illustrates the data set used; Section 4 describes the methodology employed; Section 5 presents and illustrates the empirical results; Section 6 concludes the paper.

2. Literature review and hypotheses development

The legitimacy theory has long been a conceptual foundation for researchers in understanding CSR and perceived CSR (Aramburu and Pescador, 2019), and it maintains its validity for studies investigating ESG factors, regarded as the modern "idea" of social responsibility (La Torre et al., 2021). Legitimacy is defined as a generalized perception or assumption that an organization's actions are desirable, proper or appropriate within some socially constructed system of norms, values and beliefs (Suchman 1995). It is thus evident that, engaging in socially responsible activities and reporting, companies are attempting to gain (maintain or repair) a legitimacy in the eyes of many social groups with a stake in the company (shareholders, customers, suppliers, employees, banks, government, community), by communicating to them their ESG activities and outcomes. By addressing stakeholders' expectations, companies are expected to improve their financial performance and corporate efficiency (Forgione et al., 2020). Nevertheless, firms could opportunistically communicate unreliable information to construct an external image to gain, maintain and repair legitimacy. This behaviour, opposite to the previous substantive approach, identifies a symbolic approach pursued through "greenwashing" practices that gain little credibility with stakeholders (Khan et al., 2021).

Utilities is a controversial sector under a sustainability profile, as it could generate both positive (being inspired by social purposes related to the goal of public value creation and contribution to sustainable development) and negative externalities (being among the industries with the most significant environmental impacts).

Summarising, we can underline two opposite behaviours of utilities managers in communicating their ESG performance: on the one hand, they are interested in reporting ESG to enhance the quality of disclosed sustainability information through innovative approaches like the Task Force on Climate-Related Financial Disclosures (TCFD) and the Sustainability Accounting Standards Board (SASB) guidelines (Nishitani et al., 2021; KPMG, 2022); on the other hand, they are tempted to use greenwashing policies to repair their legitimacy (Karaman et al., 2021). Empirical studies provided evidence of both the use of ESG disclosure by utilities managers to engage effectively with stakeholders (Ligorio et al., 2022; Slacik and Greiling, 2020; Valenza and Damiano, 2023) and contribute to the achievement of SDGs (Elalfy et al., 2020; Venturelli et al., 2023), and the wide adoption of greenwashing mechanisms and impression management strategies to repair legitimacy undermined by many scandals (Cong et al., 2020; Goloshchapova et al., 2019). Also, the research conducted in the mandatory European environment highlights two opposite results: whilst Caputo et al. (2021) in their study find that many utility companies provide limited information, the utilities sector emerges from the study of Posadas and Tarquinio (2021) as one of the main virtuous sectors in disclosing ESG issues.

As regards the association between ESG and firm performance, it is a vast research field providing conflicting findings, nevertheless industry-specific research is rather limited (Kaupke and zu Knyphausen-Aufseß, 2022): the study of Şeker and Güngör (2022), focused exclusively on the utilities sector, provides evidence that ESG performance has no impact on financial performance for utilities companies. Based on the theoretical and empirical literature, we posit our first research question as follows:

RQ1 Do ESG factors improve the overall efficiency of utilities companies?

Credit institutions are challenged to integrate ESG factors into their credit worthiness assessment process to contribute to creating sustainable lending, but whether incorporating ESG factors into their loan decisions led to maximizing their performance minimizing their risk is still an open question, under searched in the literature (Brogi et al., 2022). A term traditionally used by bank representatives when referring to the lending process is 'credit risk assessment', reflecting an evaluation of financial risk of repayment against financial return on investment. This means that credit risk assessment plays an important role for lending institutions, eager to include in their portfolio firms which allow them to minimize their credit risk whilst maximizing their profitability. As regards the association between ESG performance and firms' credit risk (i.e., the risk of an economic loss from the failure of a counterpart to fulfil its contractual obligation), empirical literature provided mixed evidence: Barth et al. (2022), Rouine et al. (2022), Drago et al. (2019) provide evidence that higher ESG ratings mitigate credit risks, whilst Landi et al. (2022) found that ESG ratings tend to increase the risk exposure of firms and uncertainty among investors. As regards the

Table 1
Sets, parameters and decision variables.

Sets	J: set of candidate credit applicants indexed by j
	A: set of inputs indexed by a
	B: set of outputs indexed by b
Parameters	T maximum risk budget of the bank $p_{aj}, a \in A$ value of the input
	$o_{bj}, b \in B$ value of the output
	$\pi_j, j \in J$ probability of default of the firm j
	$EL_j, j \in J$ expected loss of the firm j
Decision variables	1 if the candidate j is included into the loan portfolio $x_j =$
	0 otherwise
	v_{aj} the a-th input weight assigned with candidate j
	w_{bj} the b-th input weight assigned with candidate j
	θ_j the inefficiency score assigned with candidate j

Source: authors' elaboration

utilities sector, a recent article (Brogi et al., 2022) provides evidence that ESG scores do not affect the utilities companies' credit risk.

Despite the growing international political attention to sustainable finance (i.e., the process of taking ESG considerations into account in investment decision-making)[2] and the increasing sensitivity of stakeholders to the ESG issue, the literature has barely dealt with this issue (Coulson and Monks, 1999; Erragragui, 2018; Ahmed et al., 2018; Eliwa et al., 2021). No study, to the best of our knowledge, specifically focused on introducing ESG criteria in the bank lending process, nevertheless, Brogi et al. (2022), starting from their finding of a negative association between ESG performance score and firm credit risk for several companies from various industries and geographies, conclude that it would be appropriate for lending institutions to introduce ESG factors in the creditworthiness assessment of borrowers. The only study similar to ours is that of Pacelli et al. (2022), aiming to provide evidence that ESG score can be considered an additional criterion in selecting asset portfolios analyzing the link's intensity and the direction between the risk–return performance and the average ESG score of different sectoral funds. The authors found that the average return of all the portfolios made up of the considered ESG assets is positive, but also that it is not possible to assess a unique intensity and direction of the link between risk–return portfolio performance and average ESG score for all the sectors, as some sectors highlight a positive association between ESG scores and extra returns, some others, such as utilities, show a strong and negative link between ESG score and extra returns.

Based on the above considerations, we posit our second research question, carried out on the utilities sector, as follows:

RQ2 Could ESG factors be considered an additional criterion in banks' portfolio selection?

3. Methodology

Instead of relying on a single financial or market ratio (such as ROA, Tobin's Q, revenues), we measure the corporate performance of utilities through a model that simultaneously takes into consideration multiple inputs and outputs, providing a corporate efficiency score To obtain this value, we employed DEA (Charnes et al., 1978), a non-parametric approach, in which the efficiency measure is derived from the optimal solution of a mathematical model where multiple Input-Output variables are considered for each company, so avoiding the problem of a single metric. Different DEA approaches consider constant or variable types of return to scale in the production process and a different orientation of the problem (output, input, or input-output oriented). The DEA model we applied is an input-oriented DEA, which reflects the nature of distribution utility efficiency where outputs are not easily modifiable as inputs (Capece et al., 2021).

Even if measuring corporate performance with corporate efficiency using a DEA approach has been extensively used in the empirical literature (Xie et al., 2019; Alam et al., 2022; Stefanoni and Voltes-Dorta, 2021; Bruna et al., 2022; Pham et al., 2022) and also has been increasingly used in the utilities industry (e.g., Benito et al., 2020; Capece et al., 2021; Núñez et al., 2020), the use of DEA to measure the impact of ESG factors on corporate efficiency is still under-researched, and no study has been carried out for the utilities sector.[3]

DEA appears to be the most suitable method for addressing our RQs. In detail, DEA methodology allows the interpretation of the relationship between ESG and financial performance from the perspective of inputs and outputs, without making any assumptions about the functional relationship between them. This non-parametric approach seems to be appropriate to reveal the causal association between corporate ESG and financial performance in an unbiased way, resolving difficulties coming from the ambiguous, inconclusive and contradictory results on the association between corporate ESG and financial performance (Pham et al., 2022) and the potential reverse causal relationship between the two variables (Lu et al., 2023).

Furthermore, the DEA approach enables the differences in the efficiency of a company's input resources in terms of ESG and financial performance to be truly understood and to assess the performance of different companies comparatively through efficiency scores; in other words, the technical efficiency of a company is defined relative to the other companies of the sample, which in our research are utilities industries. The synthetic efficiency score returned by DEA allows the objective identification of the best practitioners, the position of each company with respect to them and how far inefficient companies (DMUs) are from the frontier that defines efficiency (Bruna et al., 2022).

To address our RQs, namely to investigate whether the inclusion of ESG factors improves the corporate efficiency of utilities companies (RQ1) and reduces credit risk for lending institutions (RQ2), we propose a novel integrated DEA model that overcomes the drawbacks of traditional DEA models when applied to portfolio selection. In particular, a DEA model (obtaining an assessment of the performance of each company in terms of efficiency), is combined with an asset allocation optimization model, which aims to maximize the bank profitability expressed in terms of number of loans. The key idea behind the model is that the efficiency score is regarded as an additional decision criterion in the selection of the appropriate loan portfolio. Therefore, the simultaneous DEA methodology is called in order to calculate the efficiency of

[2] The new EBA guidelines (European Banking Authority, 2020) have set out a series of principles for credit institutions to follow in managing and controlling credit risk which not only focus on the financial and capital structure of firms but also on environmental, social and management factors and qualitative and prospective information. Integration of environmental sustainability criteria in investment decisions and in support of the development of sustainable finance is required, and credit institutions have time to adapt their monitoring models by 30 June 2024 (Galletta et al., 2022).

[3] Among the studies searching a link between ESG and corporate efficiency measured with the DEA technique, we can quote the studies of Becchetti and Trovato (2011); Nollet et al. (2016); Xie et al. (2019); Alam et al. (2022); Pham et al. (2022); Lu et al. (2023). Both the studies of Becchetti and Trovato (2011) measuring ESG performance with KLD score and Nollet et al. (2016) measuring ESG disclosure with Bloomberg ESG score highlight that companies engaged in ESG could have a decline in profits in the short term, but after expenditures are covered, ESG contribution to corporate efficiency became more apparent. Xie et al. (2019) provide evidence that ESG information disclosure have a positive link with corporate efficiency, but only at a moderate level of disclosure and that ESG activities reveal a nonnegative relationship with corporate efficiency. Alam et al. (2022) study on banks provide evidence that ESG activities has an overall positive impact on the bank's efficiency. Pham et al. (2022), investigating the environmentally sensitive transportation industry, found a different impact of ESG factors on corporate efficiency, positive for environmental and social scores, negative for governance score. Lu et al. (2023), investigating Apple Inc.'s value-chain counterparts, found that ESGs positively affect firm efficiency.

all possible portfolios, and to incorporate it into the classical asset allocation model (Khodaparasti et al., 2015). We should notice that, since DEA is a comparative evaluation technique, the performance of the portfolio is strongly related to the selection decisions, and it cannot be determined regardless of the allocation choices.

Table 1 presents the sets, parameters and decision variables of our novel DEA model, a model of general applicability for loan portfolio selection which takes into account all the characteristics of this decision problem faced by the banks. Table 2 illustrates the objective functions and the constraints of the model.

The objective function (1) maximizes the bank's profitability, expressed in terms of number of loans. The objective function (2) minimizes the total inefficiency scores assigned to DMUs. Constraints are identified by numbers, from (3) to (11). In detail, constraint (3) limits the expected loss of the bank, thus limiting the credit risk; constraints from (4) to (9) relate to the DEA part of the model, that is a simultaneous DEA model: constraints (4) state that the sum of weighted inputs for any firm in the portfolio should be equal to 1, if the firm is selected. Constraints (5) ensure that the weights assigned to each firm in the portfolio are assigned in a way that the efficiency of no other firm in the portfolio is greater than 1 if it uses the same weights. Notice that these are logic constraints, which are active only when the firm is in the portfolio. Restrictions (6) define the inefficiency variable θ_j as a function of the weighted outputs. Moreover, constraints (7)–(8) guarantee that only non-dominated efficient solutions in the DEA model are investigated. Constraint (9) enforces the input and output weights associated with any firm which will not belong to the portfolio to be zero. Restrictions (10) and (11) define the nature of decision variables.

Weighting the two objectives with a parameter $\lambda \in (0, 1)$, the bi-objective model can be transformed into a single objective model as follows:

$$max : \lambda \sum_{j \in J} x_j - (1-\lambda) \sum_{j \in J} \theta_j \quad (12)$$

The proposed model captures the multi-criteria nature of lending decisions, by evaluating the loan portfolio performance along different dimensions, financial and non-financial (through the use of ESG) maximizing both the efficiency of the loan portfolio and the profitability of the loan operations. Moreover, the uncertainty associated with the provision of bank loans, which is inherently associated with the lending process, is explicitly taken into account in the model (constraint 3), respecting the well-known association risk-return. There are several measures of risk: the z-score (e.g., Altunbaş et al., 2018), the CDS spread (e.g., Drago et al., 2019), the ratio of "banks nonperforming loans to total loans" (e.g., Schulte and Winkler, 2019). In our model, risk is associated with possible losses of a bank for a specific credit portfolio, in the event of the borrower defaulting on their obligations. The expected portfolio loss is thus evaluated as the product of the probability that the default of the borrower will occur (Probability of Default) times the value of assets that are at risk at the time of default (Credit Exposure). In the model, we limit the expected portfolio loss to be lower than an upper bound (in the foregoing referred to as budget risk) through a constraint.

4. Sample and data source

The research has been carried out on the European listed utilities companies. The choice to focus the research on the European listed markets was motivated by the in-depth regulatory process embarked on by the EU to institutionalize ESG disclosure within corporate reporting practices (Baumüller and Sopp, 2022; Manes-Rossi and Nicolò, 2022). As part of the CSR strategy for 2011–2014, on 22 October 2014 the EU released Directive 95/2014, which, by imposing specific nonfinancial disclosure requirements on all public interest entities with more than 500 employees, created a "reporting cut-off point" between the European region and the other geographical contexts (EU, 2014). These circumstances make Europe an appropriate context to conduct the research.

Table 2
Objective functions and constraints.

Objective functions	$max : \sum_{j \in J} x_j,$	(1)
	$min : \sum_{j \in J} \theta_j,$	(2)
Constraints (s.t.)	$\sum_{j \in J} EL_j \pi_j \leq T,$	(3)
	$\sum_{a \in A} v_{aj} p_{aj} = x_j, \forall j,$	(4)
	$\sum_{b \in B} w_{bj} o_{bj'} - \sum_{a \in A} v_{aj} p_{aj'} \leq (1 - x_j), j, j' \in J, j \neq j',$	(5)
	$\sum_{b \in B} w_{bj} o_{bj} + \theta_j = x_j, \forall j \in J,$	(6)
	$v_{aj} \geq \varepsilon x_j, a \in A, j \in J,$	(7)
	$w_{bj} \geq \varepsilon x_j, b \in B, j \in J,$	(8)
	$w_{bj} o_{bj} \leq x_j, b \in B, j \in J,$	(9)
	$x_j \in \{0, 1\}, \forall j \in J,$	(10)
	$\theta_j \geq 0, \forall j \in J.$	(11)

Source: authors' elaboration

Measuring ESG factors is a challenging task, and the existing studies provide a remarkable variety of different measures. In several empirical works researchers built *ad hoc* performance measures using survey questionnaires, content analyses of annual reports, and expert evaluations. Consistently with Drago et al. (2019), we believe that, in contrast to measures specifically built for a single study, an ESG rating released by a specialized agency provides a measure that is public and available to the entire financial community and that can be considered reliable as it is the result of an independent evaluation and a rigorous process.

In detail, we selected Refinitiv -formerly known as ASSET4-as ESG performance rating provider, because it is an influential rating provider, considered one of the most diligent and trustworthy sources of ESG information, covering more than 4500 companies around the world (Drago et al., 2019; Berg et al., 2021), and its ESG performance ratings have been used in more than 1000 academic articles over the past 15 years (Berg et al., 2021).[4] The ESG scores are calculated on company-reported data and account for firm ESG performance. In detail, Thomson Reuters obtains and processes more than 630 ESG metrics in the public domain (data as for 2021) to set up the 186 most comparable measures, which are then grouped into 10 categories belonging to three pillars Environmental, Social and Governance.[5] The overall rating (i.e., ESG Score) is the equal weighted average of indicators of the environmental, social and governance pillar (De Villiers et al., 2022).

As Refinitiv restated its data in April 2020 in a manner that made it historically more highly correlated with returns (Berg et al., 2021), in our sample we decided to focus on 2021. The European listed utilities in Thomson Reuters Business Classification (TRBC) are divided into electric, natural gas, water & related and multiline utilities, as shown in Table 3.

The final sample, constituted of European listed utilities companies with all financial and ESG data available on Refinitiv, is made up of 67

[4] We focus on ESG performance, even if ESG performance and ESG disclosure are related (Eliwa et al., 2021; Imperiale et al., 2023), as company information is one of the main sources for the Thomson Reuters ESG ratings.

[5] Although Asset4's methodology partially changed in 2017, its overall structure remains intact. Before 2017, Asset4 comprised four pillars: (1) environmental pillar, (2) social pillar, (3) corporate governance pillar and (4) economic pillar. In 2017, the economic pillar was removed, leaving three pillars (the environmental pillar, social pillar and corporate governance pillar) composed of 10 categories and adding a new pillar, namely, ESG Controversy, which comprises 23 controversy indicators based on media (Thomson Reuters, 2017). Namely the resource use, emissions, and environmental innovation categories belong to the Environmental pillar; workforce, human rights, community and product responsibility categories belong to the social pillar; management, shareholders, and CSR strategy categories belong to the governance pillar (Refinitiv, 2022).

Table 3
Thomson reuters business classification (TRBC).

Economic sector	Business sector	Industry Group	*Industry*/Activity
Utilities	Utilities	Electric utilities and IPPs	*Electric utilities*
			-Electric utilities (NEC)
			-Fossil fuel electric utilities
			-Nuclear utilities
			-Power charging stations
			-Alternative electric utilities
			-Hydroelectric & tidal utilities
			-Solar electric utilities
			-Wind electric utilities
			-Biomass & waste to energy electric utilities
			-Geothermal electric utilities
			Independent power producers
			-Independent power producers (NEC)
			-Fossil fuel IPPs
			-Renewable IPPs
			-Nuclear IPPS
		Natural gas Utilities	*Natural gas utilities*
			-Natural gas utilities (NEC)
			-Natural gas distribution
		Water & related utilities	Water & related utilities
			-Water & related utilities
			Water supply & irrigation systems
			Sewage treatment facilities
			Heating & Air-conditioning supply
		Multiline utilities	*Multiline utilities*
			-Multiline utilities

Source: authors' elaboration

companies. For these companies we draw two input variables (Total Assets and Total Equity), three output variables (EBITDA, Revenues and ESG scores), the Total Debt (as the constraint 3 of our DEA model says that the default probability times the 20% of the total debt should be lower/equal to an expected loss of 5 million Euros) and two measures of financial reliability, the probability of default and the credit ratings, useful to verify whether the efficient (with ESG score) companies are related with a lower default probability.[6] Whilst the inputs and outputs have been defined based on the existing literature (i.e., Harrison and Rouse, 2016 used assets as input variables and Xie et al., 2019 used revenues as output variables), the inclusion of ESG performance is a novelty of our model. All the variables have been extracted from Refinitiv. Table 4 presents the summary statistics of the chosen variables, Table 5 presents the data of our DEA model.

5. Empirical results

To address RQ1, that is to assess whether ESG performance affects the overall efficiency of utilities companies, the ESG variable was firstly excluded and afterwards included in the model. In this way, we compared the corporate efficiency without ESG and the corporate efficiency with ESG, calculating a gap between these two values.

Table 6 shows the corporate efficiency results with and without ESG for the European listed utilities companies belonging to our sample.

As we can observe in Table 6, only for 16 of 67 utilities companies adding ESG factors slightly improve the company's efficiency. The median low gap value between utilities' efficiency with and without ESG is 3.04%, highlighting a low sensitivity of the utilities sector to ESG factors. The result is in line with that of Şeker and Güngör (2022), which found that the ESG rating has no statistically significant impact on financial performance for a sample of utilities companies worldwide. We also test the correlation between ESG performance score and credit risk, measured either as credit ratings or default probability for our sample. The low correlation between ESG score and respectively the default probability (0.23) and credit ratings (0.23) highlights that ESG scores do not affect the utilities' credit risk. The result is in line with the article of Brogi et al. (2022), which found that ESG scores do not affect utilities companies' credit risk (measured with Altman's Z-score).

To address RQ2, that is, whether including ESG factors in lending process improves the banks' performance reducing their credit risk, we selected the most efficient companies (10 out of 67) according to three criteria, that is, those companies which saturate the budget risk of the bank respecting both the criteria of maximum overall efficiency and low default probability (or high credit rating).

Table 7 presents the efficient companies selected according to our DEA model.

Among these ten companies selected, six companies achieve the maximum efficiency rate, but only for two of them does the ESG score make the difference (dmu33, dmu52). The other four companies were selected among efficient companies with low default probability (or high credit rating). Among these companies, the ESG score makes the difference in terms of efficiency only for one company (dmu13). Our results could be compared with those of Pacelli et al. (2022), who found evidence that the securities assuming the highest weights over time in the different portfolios were not systematically characterized by a high ESG score.

All considered, our results do not provide evidence of a strong significance of ESG factors either in affecting the overall corporate efficiency or in improving the bank's portfolio selection.

6. Conclusions

In a changed scenario, characterized by a great attention to ESG factors, how ESG performance affects the overall firm performance and credit risk has emerged as a vast research field (Kaupke and zu Knyphausen-Aufseß, 2022). Whilst extant research often finds a positive relationship between sustainable and financial firm performance (Friede et al., 2015), things are more complex in controversial sectors, characterized by both positive and negative externalities.

This paper focuses on a controversial sector, the utilities sector, with the twofold aim to investigate whether ESG performance improves the utilities overall corporate efficiency (RQ1), and whether ESG factors could actually be considered a valid criterion that credit lending managers could adopt along with traditional risk-return optimization in selecting utilities to fund (RQ2).

The research questions have been analyzed in the light of legitimacy theory. Utilities companies disclose their ESG performance to gain legitimacy, and they can follow a substantive approach, i.e., utilities' managers are interested in reporting ESG to enhance the quality of disclosed sustainability information to the stakeholders' eyes, or a symbolic approach, i.e., utilities' managers disclose unreliable ESG

Table 4
–Descriptive statistics.

Inputs/Outputs	Sum	Mean	Median	Std Dev
Total Assets	2,289,335.87	34,169.19	10,653.55	63,096.86
Total Equity	435,895.18	6505.90	3510.13	9755.39
EBITDA	138,188.36	2,062,51	976.00	3380.91
Revenues	743,074.86	11,090.67	2,622,87	24,502.09
ESG Score	4074.56	60.81	66,63	18.66

[6] The Probability of Default is calculated by Refinitiv through the smart ratio credit model, which takes into account several economic indicators, grouped under 5 macro-headings: Profit, Liquidity, Coverage, Leverage and Growth. The credit rating is another way to express the default probability with letters going from AAA to CC that we transformed in numbers (from 20 to 1).

Table 5
Data.

Dmu	TOTAL ASSETS	TOTAL EQUITY	EBITDA	REVENUE	ESG Score	TOTAL DEBT	PD	CREDIT RATING
dmu1	12,430,500,000.00	7,047,800,000.00	646,600,000.00	4,062,200,000.00	68.66	1,590,000,000.00	0.57%	10
dmu2	38,249,000,000.00	5,889,000,000.00	4,017,000,000.00	22,140,000,000.00	80.49	16,705,000,000.00	0.46%	11
dmu3	141,752,000,000.00	40,479,000,000.00	11,568,000,000.00	39,114,000,000.00	88.36	43,874,000,000.00	0.10%	16
dmu4	17,135,215,841.04	3,510,125,879.91	1,229,030,685.28	2,044,784,224.63	74.33	9,471,191,755.10	0.50%	11
dmu5	13,713,632,393.89	1,500,117,704.61	1,071,648,291.40	2,306,494,766.50	73.73	7,989,114,867.88	0.47%	11
dmu6	6,334,700,698.68	1,512,698,800.96	454,462,433.02	940,377,606.90	79.44	3,800,321,922.94	0.59%	10
dmu7	2,207,229,139.97	1,808,747,595.88	127,704,028.15	592,357,759.48	42.16	96,375,904.47	0.15%	15
dmu8	47,631,883,951.67	6,485,947,488.67	2,876,478,940.00	6,179,803,745.71	66.63	5,551,572,950.71	0.21%	14
dmu9	142,309,000,000.00	15,254,000,000.00	4,287,000,000.00	24,526,000,000.00	66.93	12,124,000,000.00	0.64%	10
dmu10	30,576,099,561.36	10,840,157,464.80	4,669,960,535.30	10,217,037,127.02	84.82	10,758,855,096.92	0.67%	10
dmu11	17,111,572,000.00	5,461,640,000.00	1,308,323,000.00	4,568,248,000.00	80.34	3,390,908,000.00	0.31%	13
dmu12	32,234,960,102.82	2,814,578,772.91	2,164,785,956.84	21,778,770,209.02	71.32	5,444,692,552.26	0.16%	15
dmu13	683,005,592.86	335,994,620.76	68,653,274.31	419,156,736.44	51.19	110,764,823.06	0.19%	14
dmu14	13,984,478,000.00	3,631,082,000.00	1,483,808,000.00	1,952,958,000.00	80.59	7,315,825,000.00	0.04%	19
dmu15	112,588,943,317.92	28,287,289,543.50	6,754,624,461.55	8,228,749,146.35	72.74	53,962,221,251.84	0.48%	11
dmu16	39,968,000,000.00	5,380,000,000.00	3,575,000,000.00	11,361,000,000.00	88.27	10,378,000,000.00	0.47%	11
dmu17	50,994,152,000.00	9,322,809,000.00	2,981,202,000.00	13,774,589,000.00	84.15	18,015,313,000.00	1.16%	8
dmu18	149,661,000,000.00	12,131,000,000.00	2,015,000,000.00	6,422,000,000.00	76.61	18,205,000,000.00	0.19%	14
dmu19	6,003,844,000.00	1,558,983,000.00	474,923,000.00	1,038,182,000.00	80.86	3,278,641,000.00	0.31%	13
dmu20	5,089,174,000.00	1,539,877,000.00	362,093,000.00	2,664,050,000.00	78.65	1,406,027,000.00	0.26%	13
dmu21	4,472,089,992.18	3,727,713,020.93	343,885,313.31	2,622,874,680.90	40.31	162,834,674.57	0.13%	15
dmu22	18,008,000,000.00	3,760,000,000.00	1,331,000,000.00	11,352,000,000.00	75.26	5,068,000,000.00	0.99%	8
dmu23	71,273,200,000.00	4,647,400,000.00	3,316,900,000.00	32,147,900,000.00	55.03	11,973,400,000.00	0.64%	10
dmu24	53,077,300,000.00	11,518,000,000.00	3,820,900,000.00	28,508,100,000.00	73.83	21,037,400,000.00	0.68%	10
dmu25	10,628,886,000.00	2,123,971,000.00	1,049,397,000.00	3,919,926,000.00	64.2	5,077,201,000.00	0.59%	10
dmu26	3,215,888,000.00	1,063,924,000.00	283,246,000.00	332,703,000.00	45.51	1,838,828,000.00	0.74%	10
dmu27	206,940,000,000.00	29,653,000,000.00	16,639,000,000.00	63,117,000,000.00	92.55	71,837,000,000.00	0.55%	11
dmu28	552,838,298.16	245,075,009.19	85,290,338.04	1,148,242,243.32	33.34	118,667,037.13	0.23%	14
dm29	1,696,021,000.00	815,167,000.00	94,781,000.00	360,764,000.00	70.46	1,356,000.00	0.12%	15
dmu30	17 79,184,000.00	5,078,678,000.00	941,122,000.00	5,016,829,000.00	44.19	4,824,740,000.00	1.81%	7
dmu31	14,031,500,000.00	3,200,200,000.00	1,097,400,000.00	10,555,300,000.00	88.87	4,312,300,000.00	0.39%	12
dmu32	22,359,200,000.00	4,681,900,000.00	1,847,200,000.00	2,534,500,000.00	83.67	12,422,000,000.00	0.59%	10
dmu33	145,960,603.88	35,289,938.42	10,458,570.09	173,807,677.33	29.86	8,549,654.93	0.19%	14
dmu34	18,144,300,000.00	4,552,000,000.00	976,000,000.00	2,551,300,000.00	54.07	7,859,300,000.00	1.24%	8
dmu35	225,333,000,000.00	36,994,000,000.00	10,486,000,000.00	57,866,000,000.00	77.86	41,048,000,000.00	0.27%	13
dmu36	1,079,747,937.62	507,516,971.70	90,818,815.83	566,655,948.84	70.58	426,788,384.27	0.69%	10
dmu37	360,966,000,000.00	50,211,000,000.00	16,619,000,000.00	84,461,000,000.00	74.81	69,406,000,000.00	1.58%	7
dmu38	6,931,599,410.13	1,529,631,330.58	464,613,764.46	6,157,441,485.49	63.53	1,769,554,831.90	0.17%	14
dmu39	1,503,622,322.12	1,281,878,505.39	350,596,739.91	1,039,741,208.88	38.94	10,403,509.95	0.05%	18
dmu40	5,588,516,000.00	1,409,830,000.00	462,116,000.00	838,353,000.00	73.22	2,750,647,000.00	0.45%	11
dmu41	1,370,555,000.00	868,544,000.00	67,593,000.00	134,911,000.00	44.59	386,262,000.00	0.63%	10
dmu42	1,042,752,000.00	247,355,000.00	93,382,000.00	95,070,000.00	59.46	667,802,000.00	0.81%	9
dmu43	1,769,918,000.00	420,889,000.00	162,749,000.00	405,406,000.00	60.53	1,003,387,000.00	0.86%	9
dmu44	36,365,242,580.84	11,036,064,667.84	2,188,625,820.66	10,446,576,130.27	72.23	7,871,548,172.16	1.19%	8
dmu45	10,977,796,539.20	7,310,583,171.30	1,474,608,255.29	4,790,338,459.54	39.25	2,016,839,934.98	0.09%	16
dmu46	22,031,576,000.00	8,766,881,000.00	1,235,485,000.00	1,580,458,000.00	74.96	4,856,630,000.00	0.31%	13
dmu47	14,870,868,280.25	10,550,613,611.60	1,388,353,684.78	2,633,209,312.92	44.01	2,703,282,791.71	0.12%	15
dmu48	9,601,043,073.59	6,812,506,990.11	1,174,604,607.67	10,944,245,691.83	69.98	1,050,458,593.31	0.14%	15
dmu49	30,303,012,364.82	13,489,727,225.91	2,916,133,064.10	10,879,121,187.15	34.74	6,260,807,339.75	0.22%	14
dmu50	7,562,074,267.98	3,060,497,623.67	790,985,078.92	4,625,043,683.95	39.23	1,577,884,206.41	0.24%	13
dmu51	19,412,087,699.37	10,363,034,116.33	1,444,243,963.79	11,505,512,042.66	43.72	2,362,197,484.81	0.38%	12
dmu52	118,656,355.06	54,448,848.56	314,527.41	73,404,762.69	31.01	3,174,946.48	1.21%	8
dmu53	8,744,232,791.76	3,598,281,795.86	896,570,244.33	5,586,926,528.59	50.21	2,856,194,815.83	0.51%	11
dmu54	4,634,061,535.41	2,183,712,583.41	541,782,408.53	2,987,549,229.82	45.47	1,325,326,761.75	0.37%	12
dmu55	11,649,178,651.61	3,778,140,664.33	564,903,341.37	1,863,178,125.41	46.24	1,808,500,727.91	0.23%	14
dmu56	1,947,250,011.31	1,692,368,110.57	351,231,339.12	630,524,360.21	40.47	60,564,543.46	0.03%	19
dmu57	8,578,382,743.80	1,356,786,704.34	697,861,547.46	1,065,927,125.34	69.09	5,330,092,170.24	0.34%	12
dmu58	3,299,211,940.91	925,936,866.25	213,454,917.28	303,451,585.72	61.3	1,909,707,329.65	3.39%	4
dmu59	128,397,000,000.00	6,303,000,000.00	5,518,000,000.00	163,978,000,000.00	66.91	8,975,000,000.00	17.78%	1
dmu60	10,152,007,000.00	1,891,414,000.00	1,039,192,000.00	2,098,463,000.00	78.01	6,376,895,000.00	0.47%	11
dmu61	1,414,206,000.00	935,200,000.00	82,807,000.00	93,090,000.00	18.68	472,709,000.00	0.29%	13
dmu62	5,447,206,584.00	183,848,940.00	694,315,638.00	1,584,531,558.00	52.09	3,700,025,892.00	0.47%	11
dmu63	4,945,100,000.00	1,364,700,000.00	294,700,000.00	333,600,000.00	29.32	2,875,500,000.00	1.32%	8
dmu64	1,022,288,637.95	177,844,004.69	216,212,950.59	1,515,359,208.68	35.73	80,539,826.52	0.81%	9
dmu65	7,636,403,758.69	1,410,240,736.67	627,481,459.50	706,662,311.24	38.3	5,330,883,587.13	4.53%	4
dmu66	10,653,548,000.00	4,975,683,000.00	1,009,951,000.00	2,472,456,000.00	31.88	3,063,038,000.00	0.50%	11
dmu67	1,004,957,180.00	309,849,950.00	56,817,380.00	140,645,120.00	56.79	508,312,460.00	0.64%	10

Source: authors' elaboration

information to secure stakeholders' support and manage the reputational risk employing greenwashing and impression management strategy.

To answer RQ1, in order to avoid problems caused by a potential reverse causal relationship among ESG and financial performance and by a wrong hypothesized functional relationship between the two variables, we employed a DEA model that returns a throughout value of corporate efficiency combining three inputs and two outputs. As our aim was is to investigate whether ESG affects the overall corporate performance, we estimate corporate efficiency without and with ESG, then we

Table 6
Efficiency scores without and with ESG.

Dmu	ESG score	Efficiency without ESG	Efficiency with ESG	GAP	PD	Credit Rating
dmu1	68.66	0.241839818	0.241839818	0.0000	0.569%	10
dmu2	80.49	0.526398362	0.526398362	0.0000	0.463%	11
dmu3	88.36	0.379458379	0.379458379	0.0000	0.100%	16
dmu4	74.33	0.337555065	0.337555065	0.0000	0.495%	11
dmu5	73.73	0.452239234	0.452239234	0.0000	0.474%	11
dmu6	79.44	0.335918024	0.339669681	0.0038	0.594%	10
dmu7	42.16	0.258654254	0.295001973	0.0363	0.147%	15
dmu8	66.63	0.319784879	0.319784879	0.0000	0.206%	14
dmu9	66.93	0.180357898	0.180357898	0.0000	0.637%	10
dmu10	84.82	0.702977202	0.702977202	0.0000	0.672%	10
dmu11	80.34	0.353751036	0.353751036	0.0000	0.311%	13
dmu12	71.32	0.584967074	0.584967074	0.0000	0.164%	15
dmu13	51.19	0.46539013	0.658986726	0.1936	0.193%	14
dmu14	80.59	0.495268462	0.495268462	0.0000	0.038%	19
dmu15	72.74	0.280387898	0.280387898	0.0000	0.476%	11
dmu16	88.27	0.476008085	0.476008085	0.0000	0.470%	11
dmu17	84.15	0.276046737	0.276046737	0.0000	1.160%	8
dmu18	76.61	0.086408865	0.086408865	0.0000	0.194%	14
dmu19	80.86	0.369234412	0.372614703	0.0034	0.314%	13
dmu20	78.65	0.343148382	0.351097273	0.0079	0.256%	13
dmu21	40.31	0.376499362	0.376499362	0.0000	0.129%	15
dmu22	75.26	0.402390789	0.402390789	0.0000	0.992%	8
dmu23	55.03	0.462408776	0.462408776	0.0000	0.637%	10
dmu24	73.83	0.349218018	0.349218018	0.0000	0.682%	10
dmu25	64.20	0.46499816	0.46499816	0.0000	0.592%	10
dmu26	45.51	0.406806862	0.409483481	0.0027	0.741%	10
dmu27	92.55	0.416357833	0.416357833	0.0000	0.553%	11
dmu28	33.34	1	1	0.0000	0.230%	14
dmu29	70.46	0.252536516	0.366309027	0.1138	0.123%	15
dmu30	44.19	0.24612929	0.24612929	0.0000	1.809%	7
dmu31	88.87	0.466243167	0.466243167	0.0000	0.387%	12
dmu32	83.67	0.388537122	0.388537122	0.0000	0.587%	10
dmu33	29.86	0.714315701	1	0.2857	0.189%	14
dmu34	54.07	0.251412658	0.251412658	0.0000	1.237%	8
dmu35	77.86	0.22630688	0.22630688	0.0000	0.267%	13
dmu36	70.58	0.3906587	0.561426921	0.1708	0.686%	10
dmu37	74.81	0.241550763	0.241550763	0.0000	1.582%	7
dmu38	63.53	0.550283133	0.550283133	0.0000	0.173%	14
dmu39	38.94	1	1	0.0000	0.045%	18
dmu40	73.22	0.386404015	0.386404015	0.0000	0.453%	11
dmu41	44.59	0.218046886	0.306811388	0.0888	0.628%	10
dmu42	59.46	0.419417262	0.566427501	0.1470	0.811%	9
dmu43	60.53	0.430616996	0.497790665	0.0672	0.857%	9
dmu44	72.23	0.279104127	0.279104127	0.0000	1.186%	8
dmu45	39.25	0.591200253	0.591200253	0.0000	0.091%	16
dmu46	74.96	0.256472554	0.256472554	0.0000	0.307%	13
dmu47	44.01	0.408401564	0.408401564	0.0000	0.124%	15
dmu48	69.98	0.655196574	0.655196574	0.0000	0.140%	15
dmu49	34.74	0.437103786	0.437103786	0.0000	0.219%	14
dmu50	39.23	0.481356785	0.481356785	0.0000	0.239%	13
dmu51	43.72	0.371133817	0.371133817	0.0000	0.380%	12
dmu52	31.01	0.297850159	1	0.7021	1.210%	8
dmu53	50.21	0.476130142	0.476130142	0.0000	0.510%	11
dmu54	45.47	0.533795553	0.533795553	0.0000	0.371%	12
dmu55	46.24	0.224192585	0.224192585	0.0000	0.225%	14
dmu56	40.47	0.773575017	0.776205117	0.0026	0.033%	19
dmu57	69.09	0.402673638	0.402673638	0.0000	0.339%	12
dmu58	61.30	0.301056244	0.330153296	0.0291	3.387%	4
dmu59	66.91	1	1	0.0000	17.782%	1
dmu60	78.01	0.483088951	0.483088951	0.0000	0.470%	11
dmu61	18.68	0.257876404	0.277380352	0.0195	0.289%	13
dmu62	52.09	1	1	0.0000	0.466%	11
dmu63	29.32	0.277497528	0.277497528	0.0000	1.319%	8
dmu64	35.73	1	1	0.0000	0.810%	9
dmu65	38.30	0.387884408	0.387884408	0.0000	4.525%	4
dmu66	31.88	0.429232624	0.429232624	0.0000	0.498%	11
dmu67	56.79	0.262001328	0.425593942	0.1636	0.638%	10
Mean gap value				**0.0304**		
Correlation coefficient					**0.2325**	**0.0862**

Source: authors' elaboration

Table 7
The selected efficient companies.

Dmu	Efficiency without ESG	Efficiency with ESG	GAP	Efficiency combined model with ESG	PD	Credit Rating	Companies Selected
dmu1	0.241839818	0.241839818	0.0000		0.569%	10	
dmu2	0.526398362	0.526398362	0.0000		0.463%	11	
dmu3	0.379458379	0.379458379	0.0000		0.100%	16	
dmu4	0.337555065	0.337555065	0.0000		0.495%	11	
dmu5	0.452239234	0.452239234	0.0000		0.474%	11	
dmu6	0.335918024	0.339669681	0.0038		0.594%	10	
dmu7	0.258654254	0.295001973	0.0363		0.147%	15	
dmu8	0.319784879	0.319784879	0.0000		0.206%	14	
dmu9	0.180357898	0.180357898	0.0000		0.637%	10	
dmu10	0.702977202	0.702977202	0.0000		0.672%	10	
dmu11	0.353751036	0.353751036	0.0000		0.311%	13	
dmu12	0.584967074	0.584967074	0.0000		0.164%	15	
dmu13	0.46539013	0.658986726	0.1936	0.6589867261	0.193%	14	
dmu14	0.495268462	0.495268462	0.0000		0.038%	19	
dmu15	0.280387898	0.280387898	0.0000		0.476%	11	
dmu16	0.476008085	0.476008085	0.0000		0.470%	11	
dmu17	0.276046737	0.276046737	0.0000		1.160%	8	
dmu18	0.086408865	0.086408865	0.0000		0.194%	14	
dmu19	0.369234412	0.372614703	0.0034		0.314%	13	
dmu20	0.343148382	0.351097273	0.0079		0.256%	13	
dmu21	0.376499362	0.376499362	0.0000		0.129%	15	
dmu22	0.402390789	0.402390789	0.0000		0.992%	8	
dmu23	0.462408776	0.462408776	0.0000		0.637%	10	
dmu24	0.349218018	0.349218018	0.0000		0.682%	10	
dmu25	0.46499816	0.46499816	0.0000		0.592%	10	
dmu26	0.406806862	0.409483481	0.0027		0.741%	10	
dmu27	0.416357833	0.416357833	0.0000		0.553%	11	
dmu28	1	1	0.0000	1	0.230%	14	
dmu29	0.252536516	0.366309027	0.1138		0.123%	15	
dmu30	0.24612929	0.24612929	0.0000		1.809%	7	
dmu31	0.466243167	0.466243167	0.0000		0.387%	12	
dmu32	0.388537122	0.388537122	0.0000		0.587%	10	
dmu33	0.714315701	1	0.2857	1	0.189%	14	
dmu34	0.251412658	0.251412658	0.0000		1.237%	8	
dmu35	0.22630688	0.22630688	0.0000		0.267%	13	
dmu36	0.3906587	0.561426921	0.1708		0.686%	10	
dmu37	0.241550763	0.241550763	0.0000		1.582%	7	
dmu38	0.550283133	0.550283133	0.0000		0.173%	14	
dmu39	1	1	0.0000	1	0.045%	18	
dmu40	0.386404015	0.386404015	0.0000		0.453%	11	
dmu41	0.218046886	0.306811388	0.0888		0.628%	10	
dmu42	0.419417262	0.566427501	0.1470		0.811%	9	
dmu43	0.430616996	0.497790665	0.0672		0.857%	9	
dmu44	0.279104127	0.279104127	0.0000		1.186%	8	
dmu45	0.591200253	0.591200253	0.0000	0.5912002528	0.091%	16	
dmu46	0.256472554	0.256472554	0.0000		0.307%	13	
dmu47	0.408401564	0.408401564	0.0000		0.124%	15	
dmu48	0.655196574	0.655196574	0.0000	0.6551965739	0.140%	15	
dmu49	0.437103786	0.437103786	0.0000		0.219%	14	
dmu50	0.481356785	0.481356785	0.0000		0.239%	13	
dmu51	0.371133817	0.371133817	0.0000		0.380%	12	
dmu52	0.297850159	1	0.7021	1	1.210%	8	
dmu53	0.476130142	0.476130142	0.0000		0.510%	11	
dmu54	0.533795553	0.533795553	0.0000		0.371%	12	
dmu55	0.224192585	0.224192585	0.0000		0.225%	14	
dmu56	0.773575017	0.776205117	0.0026	0.7762051166	0.033%	19	
dmu57	0.402673638	0.402673638	0.0000		0.339%	12	
dmu58	0.301056244	0.330153296	0.0291		3.387%	4	
dmu59	1	1	0.0000		17.782%	1	
dmu60	0.483088951	0.483088951	0.0000		0.470%	11	
dmu61	0.257876404	0.277380352	0.0195		0.289%	13	
dmu62	1	1	0.0000	1	0.466%	11	
dmu63	0.277497528	0.277497528	0.0000		1.319%	8	
dmu64	1	1	0.0000	1	0.810%	9	
dmu65	0.387884408	0.387884408	0.0000		4.525%	4	
dmu66	0.429232624	0.429232624	0.0000		0.498%	11	
dmu67	0.262001328	0.425593942	0.1636		0.638%	10	

calculated the difference (gap) between these two values. The median gap value records a value of 3.04%, signaling a low sensitivity of utilities companies to the ESG factor. In other words, investment in sustainability of utilities companies does not convey financial benefits. This result, in line with the study of Şeker and Güngör (2022), underlines that sustainability actions embraced by utilities' managers are perceived as not sincere, as greenwashing strategies that do not lead to gaining legitimacy (Wu and Shen, 2013) and could even identify a negative link between ESG and financial performance, as found by Kaupke and zu Knyphausen-Aufseß (2022) in the controversial oil & gas sector.

To answer RQ2, we use a simultaneous DEA model that minimizes the inefficiency of utilities included in the loan portfolio, maximizing the loan portfolio whilst taking into account the bank's credit risk. Our results do not provide evidence of the utility of ESG factors as a valid complementary criterion for credit lending managers beyond the traditional risk-return criterion, as highlighted also by Pacelli et al. (2022). Consistently with Pacelli et al. (2022), we believe that ESG scores are not yet able to fully and unambiguously capture ESG performance, as there is not a shared methodology to calculate ESG rating: each rating provider calculates its ESG scores starting from very different information and implementing different methodologies. This means that ESG scores attributed by different providers (i.e., Thomson Reuters, KLD, FTSE4Good, DJSI) to the same entity may differ even by a large margin, thus sending different signals to stakeholders.

Our research contributes to the literature by addressing three research gaps. First, it addresses the need for more industry-specific analyses on a sensitive industry by focusing on the utilities sector. While extant research often finds a positive relationship between sustainable and firm value (Friede et al., 2015) we show a non-significant relationship for the utilities sector. Second, our study considers listed European firms instead of North American ones. Finally, by using a DEA model, our paper switches the focus from the causal association between ESG and financial performance to a perspective of inputs and outputs, allowing the readers to truly understand the differences in the efficiency of a company's input resources in terms of overall (ESG and financial) performance.

Theoretical, managerial and policy implications could be related to our results. The theoretical contribution of the research consists of the identification of new insights about a controversial sector characterized by specific logics (Imperiale et al., 2023). While extant research often finds a positive relationship between sustainable and firm value (Friede et al., 2015), we show a non-significant relationship for the utilities sector, probably driven by a lack of credibility in the stakeholders' eyes. Researchers could thus draw parallels from studies focusing on other controversial industries and examine the motives for the non-significant/negative association between ESG and financial performance in controversial sectors more deeply.

The managerial contribution of the research is represented by the identification of potential opportunities for managers interested in legitimate their activities under a mandatory regime. Utilities managers should not use the findings to argue that all investment in sustainability beyond the mere legal requirements is useless and should be discontinued, rather, they could find ways to gain legitimacy and invest in sustainable endeavors that will not be perceived as greenwashing. For utilities companies it might be difficult to gain legitimacy in the stakeholders' eyes, as their ESG disclosure could often be perceived as insincere. Utilities' managers could invest in sustainability practices to build their corporate reputation, that is likely to mediate the effects of perceived ESG performance on stakeholders' behaviour, by enhancing the credibility of disclosed ESG information (Aramburu and Pescador, 2019).

The research also provided policy implications. The non-significance of the ESG rating both for the overall utilities corporate efficiency, and as complementary criterion beyond the traditional risk-return in the banks' portfolio optimization, could justify an approach of regulating authorities focused not on ESG performance, but instead on ESG risks (i.e., the negative materialization of ESG factors, European Banking Authority, 2021) to "force" utilities companies and banks to engage with ESG practices at this early stage of transition to sustainability (La Torre et al., 2021; Bax et al., 2022). Furthermore, considering that ESG ratings greatly differ according to the methodologies and information used by rating providers, the European Union could focus its effort on working on effective ESG regulatory initiatives.

Naturally, this study is not without limitations. First, the utilities sustainability performance has been measured by the Thomson Reuters ESG score, thus caution should be used in interpreting results, as most often used ESG ratings differ significantly in their outcome (Kaupke and zu Knyphausen-Aufseß, 2022). Secondly, because we used the Thomson Reuters ESG score as a measure of ESG performance, only publicly listed companies were included in the sample, as companies that are not publicly listed do not receive Thomson Reuters ESG ratings. Third, the analysis is limited to a specific sector and a single year. Fourth, our DEA-based approach is conditioned by the input-output model defined, by the budget constraint and of the maximum expected loss set up and also by the measure of financial value and ESG performance selected. All these limits could constitute future research directions by modifying ESG and financial performance measures, by using a more sophisticated DEA model, by widening the time span, by focusing on other controversial industries. Future researches could also be conducted to identify which of the three ESG pillars mostly impacts on the relationship between ESG and financial performance in the utilities sector by analyzing the impact of the three ESG pillars separately, with a specific attention to the environmental factor (Beelitz et al., 2021).

Credit author statement

Conceptualization – SV, MEB and GI; Methodology – SV and MEB; Data curation – GB; Validation – MEB and DM; Investigation – GI and DM; Formal analysis: GI, DM and GB; Writing – Original Draft – SV; Writing – Review & Editing – SV and MEB; Supervision: SV; Software: GB.

Declaration of competing interest

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.

Data availability

The authors do not have permission to share data.

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