Review of Managerial Science
https://doi.org/10.1007/s11846-022-00579-9

ORIGINAL PAPER

Does corporate social performance improve bank efficiency? Evidence from European banks

Maria Celia López-Penabad[1,4] · Ana Iglesias-Casal[2,4] · José Fernando Silva Neto[3] · José Manuel Maside-Sanfiz[1,4]

Received: 28 August 2021 / Accepted: 8 August 2022

Abstract

This paper analyses the impact of corporate social performance (CSP) on bank efficiency in a sample of 108 European listed banks across 21 countries over the period 2011–2019. Simar and Wilson's two-stage approach (Simar and Wilson in J Econom 136:31–64, 2007) has been applied, specifically using data envelopment analysis (DEA) at the first stage to estimate efficiency scores and then truncated regression estimation with double-bootstrap to test the significance of the relationship between bank efficiency and CSP as well as its different dimensions. Our results suggest evidence of a U-shaped relationship between CSP and efficiency, indicating that banks with either high or low corporate social performance levels are the most efficient. Considering the isolated effect of environmental, social, and governance dimensions, the same conclusion can be drawn for the latter two, while the former does not appear to have any effect on a bank's efficiency. Our work contributes to the existing literature by providing a holistic procedure for assessing CSP in terms of efficiency, allowing us to study the separate effect of each component on bank efficiency. Our results have strong implications for regulators, policymakers, bank managers and investors supporting the changes in the EU Regulatory Taxonomy that lead banks to align their activities and strategies with the Sustainable Development Goals.

Keywords Bank efficiency · Corporate social performance · DEA · Two-stage double bootstrap method · European Bank

JEL Classification G21 · M14 · Q01

✉ Ana Iglesias-Casal
ana.iglesias.casal@usc.es

Extended author information available on the last page of the article

Published online: 09 September 2022

1 Introduction

In a global and competitive market, banks, like other organisations, need to show that they are socially responsible. Throughout the advent of globalisation, as well as the added factors of environmental pollution and a scarcity of resources, banks and other large corporations have faced overwhelming pressure to run their businesses in a more socially responsible way (Gao 2009). The financial crisis in 2008 also led to more attention being paid to corporate social responsibility (CSR, henceforth), that is to say, "company activities demonstrating the inclusion of social and environmental concerns in business operations, and in interactions with stakeholders, also according to the ambition levels of corporate sustainability'' (Islam et al. 2012). CSR is now considered an essential tool to win back corporate credibility and customer trust, known as 'corporate reputation'. The improvement of employees' motivation, the desire to be perceived as an innovative organization, or the establishment of beneficial relationships with stakeholders are other reasons for this concern (Pérez et al. 2013; Izquierdo & Vicedo 2009).

According to Greenbaum and Thakor (2007) banks act as financial intermediaries in our society: they price and value financial assets, monitor borrowers, manage financial risks and organize the payment system. By carrying out these functions, banks have a significant impact on society and because of that, traditionally, face strong scrutiny, which justifies the great pains they take to maintain corporate credibility and customer trust (Pérez et al. 2013). As a result, banks are increasing their practices of social responsibility, strengthening their credibility and the trust that their stakeholders have in them (Coulson 2009). These include publishing sustainability reports following the Global Reporting Initiative (GRI) guidelines, adopting the Equator Principles and the Global Compact, and including environmental risk assessments in their credit policies, among other practices. This is, among other reasons, due to the recommendations of the European Union (Miralles-Quirós et al. 2019).

Gallego-Sosa et al. (2021) examines the degree of CSR in the European banking sector in terms of commitment to the 2030 Agenda for Sustainable Development Goals (SDGs) using a sample of the 30 largest banks in Europe in terms of market capitalization. One over three of the banks did not report that they were targeting some of the SDGs and, in mean terms, they did 5 goals. Data compiled by the authors based on each of these bank's 2017 sustainability report reflects the number of initiatives carried out and banks engaged in relation to each SDG. Initiatives were carried out for all SDGs, although the number of actions varies depending on the priority of the given SDG. The majority of initiatives and entities involved correspond to the objectives (i) Decent work and economic growth, (ii) Climate change, and (iii) Quality education. As may be noted, there is still a long way to go in this direction.

The growing interest in developing sustainable organizations has led many academics to investigate whether corporate social performance (CSP, henceforth) as a measure of CSR can improve a company's financial standing. In the banking industry, there are studies which show that CSP has an impact on banks' financial performance (Esteban-Sanchez et al. 2017; Bătae et al. 2021), market value (Miralles-Quirós et al. 2019; Azmi et al. 2021) and financial risk (Neitzert & Petras 2019). Some studies have concluded

that CSP has a positive effect on banks' financial performance (Simpson & Kohers 2002; Wu & Shen 2013), some have found a U-shaped relationship (Barnett & Salomon 2012), few have found a negative impact (Buallay et al. 2021) and others have interpreted it as an insignificant relationship (Graves & Waddock 1999). Most of these studies have analysed the relationship between CSP and traditional financial measures, such as ROA, ROE and stock price.

Our study, using a data envelopment analysis approach, analyses the relationship between CSP and each of its dimensions with bank efficiency for the European banking industry. We use an unbalanced panel data set of 108 listed banks, with 740 banks-year observations, operating in 21 European countries, over the period 2011–2019. In addition, we employ the semi-parametric two-stage double bootstrap method introduced by Simar and Wilson (2007), which enables us to obtain a more reliable measure of bank efficiency and identify their relationship with CSP.

As regards the main contributions of our work, we can highlight the following: firstly, unlike most studies that have focused on investigating the relationship between CSP and banks' financial performance, ours focuses on the relationship between CSP and bank efficiency, on which there is still very little literature—according to our best knowledge, Belasri et al. (2020) were the only ones who so far have studied this relationship. Secondly, considering that the different dimensions of the CSP can compensate each other, we analyse the individualized impact that each dimension has on bank efficiency. Thirdly, at the methodological level, we use the two-stage double bootstrap DEA (data envelopment analysis) approach, which allows us to obtain more robust and reliable results than the techniques which are typically used in this line of research based on ratio analysis. Fourthly, instead of using the CSP measures provided by certain databases, which according to some authors are quite inaccurate and subjective, we construct CSP indices using DEA models without explicit inputs, which, to our knowledge, have never been used before for the banking industry. Finally, we used a truncated regression model using algorithm II (Simar and Wilson 2007), and GMM estimation as robustness, to determine the effect of CSP and each of its dimensions on the bank's efficiency, not previously used for this purpose.

Our main results are as follows: we have found a U-shaped relationship between CSP and efficiency, indicating that banks with low or high CSP levels are the most efficient. At a disaggregated level, we have drawn the same conclusion for the social and governance dimensions of CSR activity. The environmental dimension does not seem to have any impact on the bank's efficiency. These results are framed within a period in which the Environmental, Social and Governance (ESG, henceforth) Score of the European banks analysed has shown, since 2013, an increasing trend. The same trend is evidenced by the Social and Governance Pillars, with the first registering a more accentuated growth compared to the second. The Environmental Pillar shows a different evolution, with a slightly decreasing trend until 2018 and a rise in 2019. In the same period, the efficiency of the studied banks, proxied by the cost-to-income ratio, has improved but with significant ups and downs between 2014 and 2017 (see Fig. 1).

The institutional framework, investor protection and regulatory restrictions are key elements in the determination of the banking CSP. The research that is most

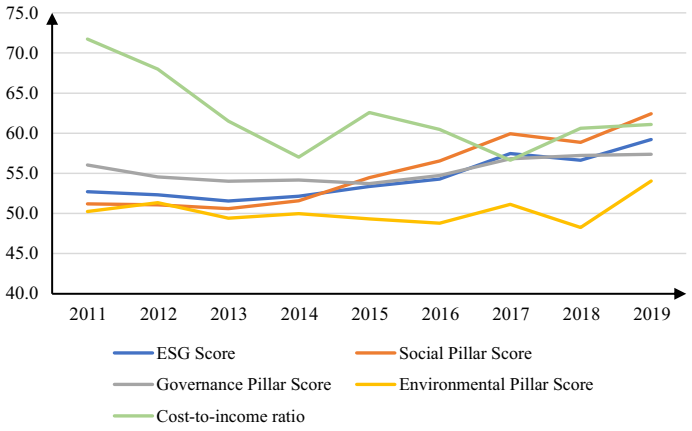

Fig. 1 ESG scores and Cost-to-income Ratio (means). Source: Own elaboration, data from Thomson Reuters Eikon Asset 4 ESG and Moody's Analytics BankFocus

directly comparable to ours, Belasri et al. (2020), have found a positive impact of CSR on bank efficiency only in developed countries, where investor protection is high, and in countries featuring a high degree of stakeholder orientation. Forgione et al. (2020) and Wang et al. (2016) have obtained similar results. Fijalkowska et al. (2018) have confirmed this difference between Central and Eastern Europe countries and many Western economies. Jo et al. (2015) have concluded that reducing environmental costs has a greater and more significant effect on the performance of financial services firms in well-developed financial markets (European banks), than in other regions with less-developed financial markets, such as the Asia Pacific. Contrarily, Buallay et al. (2021) have found that the results of the banks in developed and developing countries are similar and that ESG scores weaken performance indicators.

With this in mind, our investigation seeks to develop a procedure that allows a comprehensive assessment of banking performance in a holistic way, taking into account the specificities of the banking sector, while studying its determinants. This procedure is perfectly applicable in different banking market frameworks, despite being carried out for a European database.

The remainder of the paper is organised as follows: Sect. 2 reviews the literature on CSP and efficiency; Sect. 3 presents the methodology; Sect. 4 describes the data and variables used; Sect. 5 presents and discusses the main results; finally, Sect. 6 concludes the paper.

2 Literature review and research hypothesis

In this section, we review the literature on the relationship between CSP in its three dimensions, i.e., environmental, social and governance (ESG), and a bank's financial performance.

The matter of whether banks should incorporate practices of social responsibility into their management strategies designed to meet the expectations of their stakeholders leads to two opposing theoretical positions (Miralles-Quirós et al. 2019).

On the one hand, the Trade-Off View of CRS activity considers that any investments made in this area are a potentially inefficient use of resources. This opinion is inspired by Neoclassical Economics and most management theories, which are based on the assumption that the key corporate objective is to maximize the firm's value (Eccles et al. 2014). The Neoclassical Theory, established by Friedman (1970), argues that companies have the responsibility to put their resources into activities which aim to maximize their profits, while behaving appropriately and abiding by the basic rules of society, law and ethical customs. In this view, shareholders are seen as the key stakeholders of corporations and so to keep them happy, the resources are allocated to them. Trying to please any other stakeholder groups would negatively impact the organisation's performance (Brown & Caylor 2006). In short, companies should maximize profit. When this is achieved, their contributions to society will be optimal (Friedman 1970). The Neoclassical position, therefore, maintains that managerial staff should only be concerned with the interests of their owners or shareholders (Miralles-Quirós et al. 2019). Any other activity that prevents the company from maximizing the value for the shareholder will be considered unacceptable since a misallocation of resources will be misspent.

According to the Agency Theory, when the interests of managers are not aligned with those of shareholders, the former invest in CRS activity for their own benefits (Jensen & Meckling 1976). In particular, because investment in this type of activity is well regarded by society in general, managers build up a good image and reputation, being the costs supported by the company. Jiraporn and Chintrakarn (2013) have demonstrated that managers who are not unyielding are more likely to increase CSR activity than other CEOs. This is likely due to the private benefits and reputational benefits which CRS activity offers.

In disagreement with the views presented, we find the Stakeholder Theory developed by Freeman (1984). This theory states that a company does not belong just to owners or shareholders, meaning that it must be considered the mass of agents involved in it. In this respect, it should not be to maximize value for the shareholder, but instead, to create value for all the stakeholders, including employees, customers, local communities and natural and environmental resources. Some authors, such as Post et al. (2002), argue that companies should apply any social, environmental, and corporate governance aspects that are deemed necessary, regardless of the costs incurred or the income they produce. Stakeholder Theory suggests that environmental, social and governance practices are important issues for stakeholders. The conceptualization made by Carroll (1991) and Wood (1991) about CSR includes a stakeholder approach in which any party, such as employees, customers,

shareholders, environmentalists, communities and investors, who might be affected by certain activities a business carries out, should be considered a stakeholder.

The Resource-Based View sees investment in CRS activity as being strategic for allowing a company to gain a competitive edge by acquiring additional skills that are difficult to be replicated (Russo & Fouts 1997). This means that an increase in corporate social performance improves financial performance.

On the other hand, authors like Porter and Kramer (2011) claim that the company's objective of maximizing shareholder value should take priority while also trying to incorporate social, environmental and corporate governance measures into management as a way to create shared value for the business and for society. What they need to know is whether these measures will be profitable so that shareholder value can be maximized.

In their study on the relationship between ESG performance and shareholder value creation in the banking industry, Miralles-Quirós et al., (2019) have presented a summary of recent literature on this topic, highlighting that previous empirical evidence for the banking industry produces inconclusive results. Simpson and Kohers (2002) have provided evidence of a positive and significant relationship between CSR activity and a bank's performance. More recently, Soana (2011) has shown that there is no statistically significant link between the two measures of performance for a sample of Italian banks. Wu and Shen (2013), with a sample of 162 banks from 22 countries covering the period 2003–2009, have observed that CSR is positively associated with financial performance in terms of return on assets, return on equity, net interest income, and non-interest income but negatively associated with unproductive loans. Meanwhile, Cornett et al. (2016) have analysed the relationship between CSR and financial performance in US banks during the financial crisis and have demonstrated from their results that large banks perform significantly more CSR activities than small ones do. Shen et al. (2016), based on a sample of banks from 18 developed countries, have found that CSR banks outperform non-CSR banks in terms of return on assets and return on equity and suggest that the bank managers pursue CSR practices as a long-term survival strategy enhancing their reputation at the same time. Wu et al. (2017), for 194 depository-type banks from 22 developed countries, have confirmed that the banks engaged in more CSR tend to have better financial performance and show a mildly asymmetric V-shaped curve between the CSR degrees and four adjusted performance ratios. Esteban-Sanchez et al. (2017) have obtained mixed results after analysing the effect of different CSR dimensions on the financial performance of 154 banks in 22 countries, before and during the financial crisis. Belasri et al. (2020), using an international sample of 184 banks in 41 countries over the period 2009–2015, have found evidence that CSR has a positive impact on bank efficiency not only in developed countries but also in locations where investor protection is high and where a high degree of stakeholder orientation is considered an important feature. Shah et al. (2019), using a sample of 45 banks from 14 countries for a period of nine years (2010–2018), have presented evidence that sustainable banks are highly efficient and productive. In a more recent study for 39 European banks, for the period 2010–2019, Bătae et al. (2021) have obtained mixed results for the relationship between corporate financial performance and all dimensions of CSR activity. They have drawn the conclusion that there is a positive relationship between emission reductions and financial performance, although the same cannot be said for

its product quality and social responsibility policies. Regarding the corporate governance dimension, they refer to an increase in quality which negatively affects the bank's financial performance.

Studies of the effect of ESG on banks' performance have been widely studied, but banks in developing countries are ignored (Paltrinieri et al. 2020). Azmi et al. (2021), using 251 banks from 44 emerging economies, over the period 2011–2017, indicate that low levels of ESG activity positively impact bank value, and environmentally friendly activities have the greatest effect, however there are diminishing returns to scale. ESG activity negatively affects the cost of equity but has no effect on the cost of debt. Shakil et al. (2019), based on 93 banks from emerging markets, have shown a positive association between the banks' environmental/social performance and their financial performance. However, Finger et al. (2018) have found that adopting the Equator Principles in developed (developing) countries is associated with an increase (decrease) in funding activity and in the share of income from interest. In the Central and Eastern Europe (CEE) region, Fijalkowska et al. (2018) have revealed that being socially responsible is not reflected in the bottom line and that the financial condition does not impact the CSR engagement. However, CEE banks with better financial efficiency have higher efficiency of CSR activities.

Finally, a limited number of studies have offered contradicting evidence and challenged the positive impact of ESG on firm performance and value creation. For example, Buallay et al. (2021), using a sample of 882 banks in 80 countries from both developed and developing countries, have found a negative impact of ESG scores on every performance indicator, regardless of the type of bank (full, developed and/or developing countries). These results lend further support to the neoclassical economic theory and the principal-agent theory.

Hypothesis definition

Belasri et al. (2020) have suggested that various clues point towards ESG activities being able to have an impact on a bank's inputs and outputs, and, as a result, on bank efficiency as well; CSR activity can help firms build a strong reputation (Branco & Rodrigues 2006; Hillman & Keim 2001) which can, in turn, provide many benefits such as the increased ability to attract and retain valuable employees (Branco & Rodrigues 2006; Bătae et al. 2021). High employee productivity and loyalty are associated with good management of human capital resources or, from an efficiency perspective, a good use of inputs. On the other hand, customers may be willing to accept a lower rate on their deposits if it comes from a bank with strong CSP (Wu & Shen 2013). If a bank has a good reputation, it could actually increase profit by attracting new customers more easily and charging them higher interest on their loans. Besides this, a strong CSR-induced reputation can allow banks to charge more in fees and commission for other services (Wu & Shen 2013). CSR's expected positive impact on both interest and non-interest income indicates that CSP could increase a bank's outputs. With this in mind and in line with Stakeholder Theory, we can formulate the following hypothesis:

Hypothesis I *CSP has a positive impact on bank efficiency.*

CSP Dimensions and bank efficiency

As Xie et al. (2019) have reported, ESG activities are the result of management policies and legal obligations and comprise different dimensions. Naturally, it has a different contribution to CSP depending on the business area of the company.

The environmental dimension of CSP is a highly researched topic, but the relationship between environmental practices and corporate efficiency remains inconclusive (Ambec et al. 2013). The traditional Neoclassical View argues that environmental regulations represent an additional cost to the company that reduces profitability and leads to low efficiency (Friedman 1970). In contrast, Porter and van der Linde (1995) argue that environmentally-friendly regulation promotes technological innovation in companies, creating efficiencies that more than offset additional costs. Although banks are not seen as polluters in comparison, for example, with chemical or oil companies, they use a considerable amount of resources such as energy and paper and generate indirect carbon emissions (Bătae et al. 2021). By investing in renewable energy for office buildings, offering eco-friendly services such as e-banking apps and switching paper for electronic documents, banks can reduce their operational costs while improving their environmental performance.

According to the Resource-Based View on environmental practices, pollution prevention and product stewardship can become a source of competitive advantage via differentiation or cost savings (Hart 1995). However, Finger et al. (2018) consider that for banks in developed countries, environmental management is a form of window-dressing in the sense that they optimize their processes making that further environmental measures do not bring significant improvements to their sustainability performance.

According to Stakeholder Theory, banks that implement environmentally-responsible practices are more likely to create positive stakeholder perceptions, resulting in improved economic performance (Sila & Cek 2017). Although some studies (e.g., Wagner et al. 2002) have reported a negative relationship between these two variables, others (e.g., Bătae et al. 2021) have found a positive relationship. In this study, we posit that environmental performance is positively related to bank efficiency:

Hypothesis II *Environmental performance is positively related to bank efficiency.*

Social performance refers to how an organization treats its employees, the community and its customers by demonstrating responsibility in its products and services (Miralles-Quirós et al. 2019). According to Ben Rhouma et al. (2014), stakeholders greatly appreciate it when the business implements different social practices, particularly those related to employees' rights, training and career development, issues related to customers and the support of social causes. Starting from within the organization, stable and fair relationships between employees and management will lead to higher personal satisfaction and loyalty (Birindelli et al. 2015), contributing to an increase in corporate efficiency.

As the Equator Principles state, a socially responsible bank must optimize its credit portfolio to finance socially responsible investments. Wu and Shen (2013) argue that a bank that engages in CSR activity builds a strong sense of loyalty with its customers allowing it not only to pay them a low interest rate on deposits, but also to charge them a high interest rate on loans and high fees and commission for other services, which subsequently improves financial performance and efficiency. In this regard, we can highlight Simpson and Kohers (2002) who have observed that banks that are actively involved in their local community achieve a high level of financial performance. Fombrun (2005) also comments that these social practices can serve as a marketing tool for companies to increase demand for their products and services. Based on these arguments, we hypothesise the following:

Hypothesis III *Social performance has a positive impact on bank efficiency.*

Corporate governance is defined as an organisation's code of conduct to ensure that the actions of board members and executives are compatible with its stakeholders' interests (Esteban-Sanchez et al. 2017). Miralles-Quirós et al. (2019) refer to corporate governance as how power within a bank is exercised and how it makes decisions which guarantee that the members of its board of directors and executives act in the best interests of its long-term shareholders. The scope of corporate governance also embraces business ethics, disclosure and accountability (Shakil et al. 2019) and when it is strong, it can influence the financial performance of banks. Esteban-Sanchez et al. (2017) have found a significant positive relationship between corporate governance and bank financial performance in an international sample that includes most developed country banks while Soana (2011) has also detected one when tested alongside the asset performance of Italian banks. Based on Agency Theory, it is expected that the better the governance models in banks are, the better aligned shareholders' and managers' interests are, resulting in higher levels of efficiency. This leads us to formulate the following research hypothesis:

Hypothesis IV *The relationship between corporate governance quality and bank efficiency is positive.*

A Non-Linear Relationship between CSP (and each of its dimensions) and Bank Efficiency

In an attempt to reconcile the two opposing views on the relationship between CSP (and each of its dimensions) and bank efficiency and in line with Nollet et al. (2016) and Shabbir et al. (2020), we have also tested for whether the relationship between these two variables is non-linear. It seems fair to say that if levels of CSR activity are low, when they increase, bank efficiency decreases because the benefits still do not cover the costs. However, it is expected that after a certain level of CSR activity, when it increases, it will have a positive impact on bank efficiency. This means that the most efficient banks will have low or high levels of CSP. Banks with an intermediate level of CSP will be the least efficient. Based on this idea, we have formulated the following research hypothesis:

Hypothesis V *The relationship between CSP (and each of its dimensions) and bank efficiency is non-linear.*

3 Methodology

To investigate the formulated hypotheses, we will have to measure bank efficiency. Over time, in operational research, several techniques, both parametric and nonparametric, have been developed to measure corporate efficiency. Among the non-parametric techniques, Data Envelopment Analysis (DEA) has been extensively used in the efficiency evaluation of banks. Radojicic et al. (2018) have presented an excellent review of research on bank efficiency that uses the DEA technique. The efficiency measurement indicates whether a bank maximizes the output quantity by using the given quantity of inputs or minimizes the quantity of inputs used to produce a given output quantity.

We have applied Simar and Wilson's (2007) method in a two-stage procedure to estimate bank efficiency and to study its relationship with CSP and its components. In general, two major problems arise when the analysis is based on a conventional two-step procedure: (i) the lack of a well-defined data generating process (e.g., inappropriate censored regression) and (ii) misleading inference. To overcome these problems, Simar and Wilson (2007) have proposed a double-bootstrap DEA approach that is grounded on statistical theory. In the first stage, it combines the classical DEA model with the bootstrap procedure to estimate the relative efficiency scores and confidence intervals. In the second stage, efficiency estimates are regressed on a set of explanatory variables, including ESG variables, using the truncated regression with bootstrap. The authors have proposed two algorithms to implement the two-stage procedure described. We have used algorithm II, which is more involved and rests on bias-corrected DEA scores as the left-hand-side variable of the truncated regression from the second stage.

Stage 1: Estimation of Efficiency Scores.

Using linear programming, the DEA technique allows the production frontier to be estimated and the efficiency score of a DMU (Decision Making Unit) to be calculated to homogeneous entities. Our study focuses on European banking and assumes that the banks considered have similar characteristics and the following common production frontier: (i) a common economic objective (maximizing shareholder wealth), (ii) similar activities (with most performing typical commercial banking activities), (iii) a similar regulatory environment and (iv) a similar legal form.

Since the original study by Charnes et al. (1978), many DEA models have been proposed in the literature (static or dynamic, with constant or variable returns to scale). The most popular are the CCR (Charnes et al., 1978) and the BCC (Banker et al. 1984) models. Both are based on radial efficiency measurements and can be carried out from both orientations (either input or output). The CCR model is based on the assumption of constant returns to scale (CRS) and the BCC model assumes that the evaluated entity may be operating under the variable returns to scale (VRS) hypothesis; this implies that the relative efficiency of each DMU is obtained by comparing it with others that are efficient and possess similar operational dimensions. The CRS assumption

is only justifiable when all DMUs are operating at an optimal scale. However, banks or DMUs in practice might face either economies or diseconomies to scale, so in this work, following Grmanová and Ivanová (2018), we have used the BCC model.[1] The VRS assumption provides the measurement of pure technical efficiency, which is the measurement of technical efficiency devoid of scale efficiency effects (Řepková, 2014).

We have considered the output orientation because banks usually aim to maximize profits with an adequate combination of productive factors (inputs).

For each period t (t=1, 2, …,T), we have considered that there are n_t DMUs (i=1, 2, …, n_t), for which we have taken a set of q outputs (r=1, 2,…,q) into account that produce $Y_{it} = \{y_{rit}\}$ and p inputs (s=1, 2,…,p) that consume $X_{it} = \{x_{sit}\}$. The BCC model, with output orientation, maximizes the output, keeping the inputs unchanged, and can be mathematically represented as:

$$Max\theta_{0t} \tag{1}$$

subject to:

$$x_{s0t} - \sum_{i=1}^{n_t} \lambda_{it} x_{sit} \geq 0 \qquad s = 1, 2, \ldots, p \tag{2}$$

$$\sum_{i=1}^{n_t} \lambda_{it} y_{rit} - \theta_{0t} y_{r0t} \geq 0 \qquad r = 1, 2, \ldots, q \tag{3}$$

$$\sum_{i=1}^{n_t} \lambda_{it} = 1 \tag{4}$$

$$\lambda_{it} \geq 0 \quad i = 1, 2, \ldots, n_t \tag{5}$$

where θ_0 is the efficiency score of DMU_0 and λ is the weight. More precisely, θ_0 represents by how much all outputs must be multiplied, keeping inputs unchanged, for the DMU_0 to reach the efficient frontier. If θ_0 is equal to 1, the DMU_0 is efficient, if θ_0 is greater than 1, the DMU_0 is inefficient and higher values mean more inefficiency.

Because the empirical study has been carried out on panel data, we have estimated the value of θ for each bank using a one-year window, as suggested by Charnes et al. (1994).

One of the weaknesses of the DEA methodology is that it tends to generate biased estimates of θ. To correct this weakness, we have used the procedure proposed by Simar and Wilson (2000), bootstrapping the initial efficiency scores and obtaining bias-corrected efficiency estimations $\hat{\hat{\theta}}_{it}$.

[1] In the robustness analysis, other DEA models such as the SBM (Slacks-Based Measure) and the DDF (Directional Distance Function) were used.

Stage 2: Estimation of Truncated Regression.

Next, to determine the effect of CSP and each of its dimensions on the bank's efficiency, we have estimated a truncated regression model using algorithm II, as proposed by Simar and Wilson (2007), where the efficiency score, from the first stage, is regressed against a set of variables that can potentially explain the bank's efficiency, including the CSP variable and its three dimensions.

The second stage regression is given by:

$$\hat{\hat{\theta}}_{it} = \delta CSP_{it} + \beta Z_{it} + \eta D_t + \varepsilon_{it} \tag{6}$$

where $\hat{\hat{\theta}}_{it}$ is the dependent variable, the bootstrapped bias-corrected efficiency score of bank i in year t; CSP_{it} is a variable that measures the CSR of bank i in year t or one of its dimensions; Z_{it} is a vector of control variables that are expected to explain bank efficiency; D_t is a vector of year dummies; δ, β and η are the parameters to be estimated in the second stage; ε_{it} is an independent error that follows the normal distribution with a zero mean and σ_ε^2 variance $N\left(0, \sigma_\varepsilon^2\right)$ with left-tail truncation $\left(1 - \delta CSP_{it} - \beta Z_{it} - \eta D_t\right)$.

To implement Simar and Wilson's (2007) algorithm II, the following steps must be carried out:

1. For each year $t = 1, 2, \ldots, T$, using original data of outputs, Y_{it}, and inputs, X_{it} (all of which must be positive), estimate DEA efficiency scores for each bank, $\hat{\theta}_{it}$;
2. Use the method of maximum likelihood to obtain estimates $\hat{\delta}$, $\hat{\beta}$ and $\hat{\eta}$ of δ, β and η, respectively, as well as an estimate $\hat{\sigma}_\varepsilon$ of σ_ε in the truncated regression of $\hat{\theta}_{it}$ on CSP_{it}, Z_{it} and D_t in Eq. (6) using the observations when $\hat{\theta}_{it} > 1$;
3. For each $i = 1, 2, \ldots, n_t$ and $t = 1, 2, \ldots, T$, loop over the next four ([3.1.]-[3.4.]) steps L_1 times to obtain a set of bootstrap estimates $\mathfrak{B} = \left\{\hat{\theta}_{it}^b\right\}_{b=1}^{L_1}$:
   - 3.1 Generate the residual $\tilde{\varepsilon}_{it}$ from the normal distribution $N\left(0, \hat{\sigma}_\varepsilon^2\right)$ with left-truncation at $\left(1 - \hat{\delta} CSP_{it} - \hat{\beta} Z_{it} - \hat{\eta} D_t\right)$
   - 3.2 Compute $\tilde{\theta}_{it} = \hat{\delta} CSP_{it} + \hat{\beta} Z_{it} + \hat{\eta} D_t + \tilde{\varepsilon}_{it}$
   - 3.3 Set $X_{it}^* = X_{it}$ and $Y_{it}^* = Y_{it}\left(\hat{\theta}_{it} / \tilde{\theta}_{it}\right)$
   - 3.4 Use X_{it}^* and Y_{it}^* to estimate the pseudo-DEA efficiency scores $\hat{\theta}_{it}^b$;
4. For each $i = 1, 2, \ldots, n_t$ and $t = 1, 2, \ldots, T$, compute the bias-corrected efficiency as:

$$\hat{\hat{\theta}}_{it} = \hat{\theta}_{it} - \widehat{bias}_{it}$$

$\widehat{bias}_{it}$ is the bootstrap estimator of bias, according to Simar and Wilson (1998):

$$\widehat{bias}_{it} = \left(\frac{1}{L_1} \sum_{b=1}^{L_1} \hat{\theta}_{it}^{b} \right) - \hat{\theta}_{it}$$

5. Use the method of maximum likelihood to estimate the truncated regression of $\hat{\hat{\theta}}_{it}$ on CSP_{it}, Z_{it} and D_t to obtain estimates $\hat{\hat{\delta}}$, $\hat{\hat{\beta}}$ and $\hat{\hat{\eta}}$ of δ, β and η, respectively, as well as an estimate $\hat{\hat{\sigma}}_{\varepsilon}$ of σ_{ε};
6. For each $i = 1, 2, \ldots, n_t$ and $t = 1, 2, \ldots, T$, loop over the next three ([6.1.]-[6.3.]) steps L_2 times to obtain a set of bootstrap estimates $\mathfrak{D} = \left\{ \hat{\hat{\delta}}^{b}, \hat{\hat{\beta}}^{b}, \hat{\hat{\eta}}^{b}, \hat{\hat{\sigma}}_{\varepsilon}^{b} \right\}_{b=1}^{L_2}$:
   6.1 Generate the residual $\tilde{\tilde{\varepsilon}}_{it}$ from the normal distribution $N\left(0, \hat{\hat{\sigma}}_{\varepsilon}^{2}\right)$ with left-truncation at $\left(1 - \hat{\hat{\delta}} CSP_{it} - \hat{\hat{\beta}} Z_{it} - \hat{\hat{\eta}} D_t\right)$
   6.2 Compute $\tilde{\tilde{\theta}}_{it} = \hat{\hat{\delta}} CSP_{it} + \hat{\hat{\beta}} Z_{it} + \hat{\hat{\eta}} D_t + \tilde{\tilde{\varepsilon}}_{it}$
   6.3 Use the maximum likelihood method to estimate the truncated regression of $\tilde{\tilde{\theta}}_{it}$ on CSP_{it}, Z_{it} and D_t to obtain a set of bootstrap estimates $\hat{\hat{\delta}}^{b}$, $\hat{\hat{\beta}}^{b}$ and $\hat{\hat{\eta}}^{b}$ of δ, β and η, respectively, and $\hat{\hat{\sigma}}_{\varepsilon}^{b}$ of σ_{ε};
7. Calculate confidence intervals and standard errors for $\hat{\hat{\delta}}$, $\hat{\hat{\beta}}$, $\hat{\hat{\eta}}$ and $\hat{\hat{\sigma}}_{\varepsilon}$ from the bootstrap distribution of $\hat{\hat{\delta}}^{b}$, $\hat{\hat{\beta}}^{b}$, $\hat{\hat{\eta}}^{b}$ and $\hat{\hat{\sigma}}_{\varepsilon}^{b}$.

In the empirical investigation, a truncated regression also including a quadratic term of CSP_{it} has been estimated to investigate the hypothesis of a non-linear relationship between CSP and bank efficiency (Hypothesis V).

To estimate Eq. (6), a measure for the bank's CSP and each of its dimensions needs to be obtained. Nowadays, this concept is widely recognised in the academic and professional world as a multidimensional construct that essentially covers three aspects related to environmental, social and governance issues. This multidimensionality implies that a unidimensional quantitative index is necessary to account for the simultaneous organisational aspects when assessing CSP (Belu & Manescu 2013). In the past, many empirical studies frequently employed the Kinder, Lydenberg, Domini (KLD) data set, which became the standard measure of CSP in academic research (Mattingly 2017). However, a considerable number of researchers have questioned the weighting system used by the KLD and other indexes provided by CRS rating agencies in aggregating the different CSP dimensions into one single measure (Crane et al. 2017). According to Capelle-Blancard and Petit (2017), this aggregation process is rather inaccurate and subjective and should not be the same across all the sectors.

To overcome these measurement issues, we have turned to the DEA models without explicit inputs (DEA-WEI models),[2] which were initially proposed by Lovell and Pastor

[2] Belu & Manescu (2013) have applied the same approach to construct a CSR index for a sample of 405 large non-financial publicly traded companies listed on the main international stock exchanges. Lahouel et al. (2021) have applied this approach to the airline industry.

(1999). DEA-WEI models are suitable when input variables are not available and when the focus of an evaluation activity lies in the performance rather than the efficiency of assessed DMUs, as is often the case (Lahouel et al. 2021). In our empirical analysis, we have constructed four DEA indices (namely, global CSP, environmental, social and corporate governance ones), where no particular quantity is considered an input and in which the different dimensions of CSP are the outputs. While it is obvious that achieving a given level of CSP might require material inputs, it is usually not clear how they become CSP scores. Thus, we have treated each as a stand-alone unit, without identifying the various inputs that are involved in accomplishing ESG-related goals.

Considering that for each period t ($t=1, 2, \ldots, T$), there are n_t DMUs ($i=1, 2, \ldots, n_t$), with s attributes in terms of CSP ($g=1, 2, \ldots, s$) given by $Y_{it} = \{y_{git}\}$, the BCC-WEI model, with output orientation, which maximizes the performance in terms of CSP can be mathematically represented as:

$$Max\phi_{0t} \tag{7}$$

subject to:

$$\sum_{i=1}^{n_t} \lambda_{it} y_{git} - \theta_{0t} y_{g0t} \geq 0 \quad g = 1, 2, \ldots, s \tag{8}$$

$$\sum_{i=1}^{n_t} \lambda_{it} = 1 \tag{9}$$

$$\lambda_{it} \geq 0 \quad i = 1, 2, \ldots, n_t \tag{10}$$

where $\phi_0 \geq 1$ represents an index of performance in terms of CSP of DMU_0 and λ is the weight. Higher values of ϕ_0 mean that DMU_0 performs worse than other DMUs in terms of CSP. As with determining the bank's efficiency, we have estimated the value of ϕ for each bank using a one-year window and bootstrapped the initial coefficients, using Simar & Wilson's procedure (2000) to obtain bias-corrected estimations $\hat{\hat{\phi}}_{it}$.

4 Data and variables

Our data set consists of an unbalanced panel data sample of 108 European listed banks observed over the period 2011–2019 with the ESG data coming from the Thomson Reuters Eikon Asset 4 ESG database. The sample consists of 740 bank-year observations and its distribution by country, in terms of the number of banks, is the following: Austria (3), Belgium (3), the Czech Republic (2), Denmark (4), Finland (2), France (4), Germany (6), Greece (4), Hungary (1), Ireland (4), Italy (15), Liechtenstein (1), the Netherlands (3), Norway (7), Poland (10), Portugal (2), Romania (2), Spain (8), Sweden (5), Switzerland (9) and the United Kingdom (13). The bank's accounting data used in this research has been obtained from Moody's Analytics BankFocus database, with

all data converted to euros. The macroeconomic data has been taken from Thompson Datastream.

4.1 DEA specification for bank efficiency

The estimation process of the DEA model starts with the selection of potential model variables, i.e., the combination of inputs and outputs. The selection could be based on three basic approaches to banking: the intermediation approach, the production approach and the profitability approach (Titko et al. 2014), The intermediation approach emphasises the financial intermediary role which banks play, treating loans and securities as outputs and deposits, labour and capital as inputs (Barros et al. 2011). The production approach assumes that banks use capital and labour to offer different kinds of banking services including loans as well as deposits (Staub et al. 2010). Finally, the profitability approach is quite similar to the production approach but with outputs oriented for profitability such as interest income and non-interest income (Avkiran 2015).

Because we are interested in measuring the efficiency of the whole bank and not just its branches, we have used the intermediation approach, with the following potential inputs and outputs being taken into consideration:

Inputs	Personnel Expenses (I)PE–Total of staff expenses
	Deposits (I)DEP–Total of customer deposits
	Fixed Assets (I)FA–Total of tangible and intangible assets
	Average Cost of Labour (I)ACL–Staff expenses divided by the number of employees
Outputs	Loans (O)L–Total of loans & advances to customers
	Earning Assets (O)EA–Total of loans & advances to customers and other interest earning assets
	Non-Interest Income (O)NII–Total of net fee & commissions, net trading income, net dividend income, net insurance income and other non-interest income

To select which inputs and outputs to include in the final DEA model, many researchers have suggested several methods (see, e.g., Jenkins & Anderson 2003). The simplified method to determine relevant variables is to omit highly correlated ones from the list (Luo et al. 2012).

Tables 1 and 2 show the descriptive statistics and Spearman's rank correlation test, respectively, for the potential inputs and outputs, in the period 2011–2019 (monetary values in millions of euros).

Based on the correlation analysis, we have considered the input combinations in which Spearman's rank correlation coefficient is less than 0.9. This has allowed us to take the combinations between the input *Average Cost of Labour* and the other three into account. Because, in theory, it is not very plausible to consider a production function where the *Average Cost of Labour* and *Personnel Expenses* are both inputs, we have excluded this combination. Taking the correlation coefficients between the outputs into consideration, we can conclude that the *Earning Assets* are highly correlated with *Loans*. As our sample is essentially formed of commercial banks whose main output is loans, we have regarded the outputs of the DEA model as *Loans* and *Non-Interest Income*. Thus, we have considered the following two alternative models:

Table 1 Descriptive statistics of potential inputs and outputs for the efficiency model

	(I)PE	(I)DEP	(I)FA	(I)ACL	(O)L	(O)EA	(O)NII
Mean	2454.8	131,250.1	2193.2	0.0776	172,475.0	284,659.8	3202.5
Median	667.5	37,208.5	511.5	0.0713	48,132.5	64,448.5	847.5
Std. Dev	3798.3	200,466.2	4092.1	0.0465	242,305.1	445,305.6	5233.3
Min	9.0	77.0	1.0	0.0092	472.0	2056.0	0.0
Max	18,279.0	1,281,035.0	34,262.0	0.2957	1,251,085.0	2,148,107.0	41,268.3
Obs	740	740	740	740.0	740	740	740

Table 2 Spearman's rank correlation coefficients

	(I)PE	(I)DEP	(I)FA	(I)ACL	(O)L	(O)EA	(O)NII
(I)PE	1						
(I)DEP	0.937***	1					
(I)FA	0.921***	0.916***	1				
(I)ACL	0.217***	0.117***	0.057	1			
(O)L	0.921***	0.938***	0.858***	0.314***	1		
(O)EA	0.930***	0.936***	0.860***	0.271***	0.991***	1	
(O)NII	0.941***	0.904***	0.851***	0.334***	0.843***	0.876***	1

*, ** and *** indicate statistical significance at levels of10%, 5% and 1%, respectively

Model 1: (I)DEP, I(ACL), (O)L and O(NII).
Model 2: (I)FA, I(ACL), (O)L and O(NII).

The proposed models satisfy the isotonicity property, which requires that outputs do not decrease with an increase in inputs since the coefficient correlations between inputs and outputs are positive and significant (Bowlin 1998).

4.2 A bank's CSP and its dimension indices

The CSP index has been calculated using the DEA-WEI model described in Eqs. (7–10). As the CSP index evaluates the efficiency of how a bank handles its primary stakeholders, we have chosen to follow Lahouel et al. (2021); we have decided that the ten categories which describe the three ESG pillars from the Thomson Reuters Eikon Asset 4 ESG database, presented in Table 3, should be the outputs of our DEA-WEI model.

To construct the indices of all the CSP dimensions, we have picked the following categories: Environmental index (Resource Use, Emissions and Innovation), Social index (Workforce, Human Rights, Community and Product Responsibility) and Governance index (Management, Shareholders and CRS Strategy). Table 4 presents the descriptive statistics for the scores which the ten categories below have received (ranging from 0 to 100) for the period 2011–2019.

Table 3 Categories from Thomson Reuters Eikon Asset 4 ESG database used in CSP estimations and each of its dimension indices

Pillar	Category	Description (according to Reuters)
Environmental	Resource Use Score (RUS)	The Resource Use Score reflects a company's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management
	Emissions Score (ES)	The Emissions Score measures a company's commitment and effectiveness towards reducing environmental emissions in its production and operational processes
	Innovation Score (EIS)	The Innovation Score reflects a company's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes, or eco-designed products
Social	Workforce Score (WS)	The Workforce Score measures a company's effectiveness in terms of providing job satisfaction, a healthy and safe workplace, maintaining diversity and equal opportunities and development opportunities for its workforce
	Human Rights Score (HRS)	The Human Rights Score measures a company's effectiveness in terms of respecting the fundamental human rights conventions
	Community Score (CS)	The Community Score measures the company's commitment to being a good citizen, protecting public health and respecting business ethics
	Product Responsibility Score (PRS)	The Product Responsibility Score reflects a company's capacity to produce quality goods and services, integrating the customer's health and safety, integrity and data privacy
Governance	Management Score (MS)	The Management Score measures a company's commitment and effectiveness towards following best practice corporate governance principles
	Shareholders Score (SS)	The Shareholders Score measures a company's effectiveness towards equal treatment of shareholders and the use of anti-takeover devices
	CSR Strategy (CSRSS)	The CSR Strategy Score reflects a company's practices to communicate that it integrates economic (financial), social and environmental dimensions into its day-to-day decision-making processes

Taken from Environmental, Social and Governance (ESG) Scores from REFINITIV (February 2021). Available at https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf

Table 4 Descriptive statistics for ESG scores used in DEA-WEI model estimation for CPS and each of its dimension indices

	RUS	ES	EIS	WS	HRS	CS	PRS	MS	SS	CSRSS
Mean	55.55	56.05	47.45	71.92	37.95	51.13	46.48	57.88	52.54	47.78
Median	64.91	63.35	53.06	78.74	30.10	51.73	43.98	62.50	52.31	50.00
Std. Dev	34.41	31.52	37.00	23.32	36.33	31.02	33.36	29.30	27.98	32.09
Min	0	0	0	0.54	0	0	0	1.04	0.39	0
Max	99.77	99.88	99.49	99.91	98.10	99.77	99.79	99.61	99.38	99.45
Obs	740	740	740	740	740	740	740	740	740	740

4.3 Other determinants of bank efficiency

To ensure that CSP and each of its dimensions do not replace the known effect of other variables on bank efficiency, we have considered a set of control variables previously identified in the literature. These can be divided into two categories: *bank-specific* and *country*.

In the first category, we have included and measured *bank size* by the natural logarithm of total assets (Belasri et al. 2020), *revenue diversification* by the ratio of non-interest income over operating revenues and *Liquidity* by liquid assets over total assets. We have also considered a measure of *bank profitability*, the return on assets[3] (Belu & Manescu 2013), a measure of *bank leverage*, the equity to assets ratio (Shakil et al. 2019), and a measure of *credit risk*, the non-performing loans (NPL) ratio (Phung et al. 2022). To control the effect of board composition on bank efficiency, we have selected a *board independence* indicator (percentage of independent directors on the board) and *board gender diversity* (percentage of women on the board) (Gordini & Rancati 2017; Rehman et al. 2020). Lastly, following Mateev & Bachvarov (2021), was considered a variable that reflects the bank *ownership structure* (a dummy variable that takes the value of 1 when one of the shareholders controls 25% or more of the capital and 0 otherwise).[4]

In the second category, we have included four macroeconomic variables, namely: *real gross domestic product (GDP) growth*, *inflation rate*, *domestic credit to private sector as a percentage of GDP* and *GDP per capita* to control the effect of the economic environment on bank efficiency. Finally, the *Herfindahl–Hirschman Index* (HHI), which is measured as the sum of the squares of a bank's total banking asset market share in a specific country, in order to proxy the market structure of the banking sector (the closer the HHI is to a score of 1 the higher the concentration is).

In Table 5, we have presented the descriptive statistics for the control variable over the period 2011–2019.

[3] Other studies to measure the bank profitability have considered the earnings to total assets ratio and earnings to gross loans (Mateev & Bachvarov 2021), which in our sample have shown to be highly correlated with return on assets.

[4] No variable was included for government ownership because almost all the banks in the sample are private.

Table 5 Descriptive statistics of control variables of bank efficiency

	Obs	Mean	Median	Std.Dev	Min	Max
Size	740	11.47	11.19	1.64	7.78	14.72
Revenue diversification	740	42.55	39.85	23.70	−7.95	319.51
Liquidity	740	27.07	24.98	13.92	2.44	91.24
Return on assets	740	0.41	0.46	1.39	−13.41	6.29
NPL ratio	740	7.72	4.45	9.47	0.06	53.29
Equity to assets ratio	740	8.42	7.03	7.92	−3.93	76.91
Board independence	740	54.95	57.14	24.24	0.00	100.00
Board gender diversity	740	23.48	23.53	13.94	0.00	60.00
Ownership structure	740	0.07	0	0.25	0.00	1.00
HHI	740	0.09	0.07	0.06	0.02	0.39
Real GDP growth	740	1.69	1.67	2.76	−9.13	25.16
Inflation	740	1.24	1.14	1.23	−1.74	5.65
Domestic Credit / GDP	740	104.73	97.37	38.84	24.74	187.24
GDP per capita	740	44,044.9	42,912.88	13,058.9	22,827.7	87,379.7

All variables are in percentages, except Size, Ownership structure and HHI (in units) and GDP per capita (in euros)

5 Results and discussion

5.1 Bank efficiency scores and ESG indices

We have applied the methodology described in Sect. 3, and we have estimated the BCC model, with output orientation to obtain the estimates of the bank efficiency score $\left(\widehat{\theta}\right)$ and the bias-corrected efficiency score $\left(\widehat{\widehat{\theta}}\right)$ for models 1 and 2, which were proposed in Sect. 4.1. Table 6 presents the mean values of the estimated coefficients, as well as the number of banks used in the estimation and the percentage of fully efficient banks for both models.

In general, the level of bank efficiency in Europe for the period 2011–2019 is low. Considering the efficiency scores of models 1 and 2, we can conclude that, if the inputs are unchanged, the outputs have to multiply, on average, by 2.011 and 1.781 times, respectively, for a given bank to reach the efficient frontier. These results are in line with those obtained by Neves et al. (2020) and Christopoulos et al. (2020), who have reported low levels of efficiency in European banking for the periods 2011–2016 and

Table 6 Bank efficiency score and bias-corrected efficiency score (mean) by year based on the BCC model, with output orientation, using DEA

Year	Model 1			Model 2			Number of banks
	Inputs: I(DEP) and I(ACL)			Inputs: I(FA) and I(ACL)			
	Outputs: O(L) and O(NII)			Outputs: O(L) and O(NII)			
	Efficiency Score	Bias-corrected efficiency score	% Efficient DMUs	Efficiency Score	Bias-corrected efficiency score	% Efficient DMUs	
2011	2.177	2.569	13.89	2.022	2.395	12.50	72
2012	1.681	1.898	18.06	1.668	1.903	12.50	72
2013	1.701	1.925	13.70	1.585	1.789	13.70	73
2014	2.265	2.714	13.51	2.254	2.764	16.22	74
2015	1.843	2.135	13.92	1.614	1.817	17.72	79
2016	1.860	2.153	13.25	1.515	1.673	22.89	83
2017	2.231	2.667	11.36	2.161	2.581	22.73	88
2018	2.182	2.580	9.26	1.715	1.960	21.30	108
2019	2.053	2.410	8.79	1.550	1.761	21.98	91
2011–2019	2.011	2.355	12.57	1.781	2.062	18.38	740

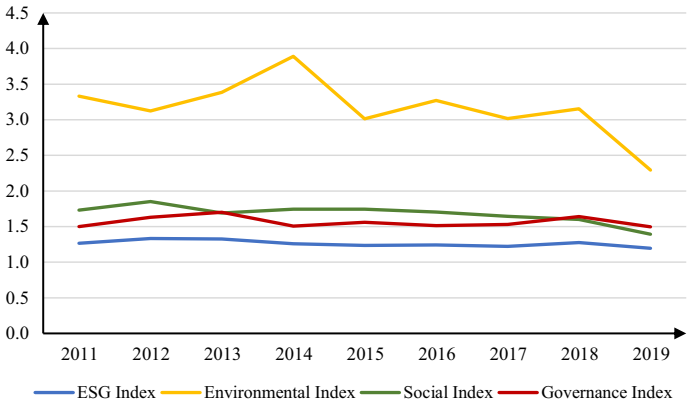

Fig. 2 Bank ESG activities and each of their dimensions as bias-corrected indices (means)

2009–2015, respectively, which could be due to activity restrictions and high capital requirements imposed by the regulatory authorities during the European sovereign debt crisis (Bace & Ferreira 2020).

The bias-corrected efficiency scores above show that the rankings do not change substantially, although efficiency scores do generally rise. Comparing the results obtained for models 1 and 2, we can conclude that both the average efficiency score and the percentage of efficient DMUs are higher in model 2,[5] and for this reason, the bias-corrected efficiency scores of this model have been used to estimate the truncated regression of the second stage.

To measure CSP, ESG indices have been estimated using the DEA-WEI model described in Sects. 3 and 4.2. Figure 2 presents the evolution of the mean value for the bias-corrected indices of ESG activities and each of their dimensions $\left(\hat{\hat{\phi}}\right)$.[6] As we can see, in the period 2011–2019, European banks show good levels of performance for ESG activities with the bias-corrected efficiency score at an average value of 1.233, which means that it is very close to unity.

In the Social and Governance dimensions of CSP, it can be concluded that European banks also have good levels of performance. The mean value of the corporate governance index ranges between a minimum value of 1.495 for 2019 and a maximum value of 1.702 for 2013. In the activities related to the social pillar, there is even an increase in performance, with the respective index decreasing from 1.731 in 2011 to 1.393 in 2019. The environmental dimension performs worst among the components for CSP in European banks, with an average index of 3.140 in the period 2011–2019. This result is to be somewhat expected as banking activity, at

[5] It should be remembered that a fully efficient bank will have a coefficient θ equal to one and a higher coefficient means that the bank is less efficient.

[6] In Table 12 of the appendix, there is detailed information about the evolution of ESG activities and their dimension indices, by year, using the DEA-WEI model.

Table 7 Descriptive statistics of bank efficiency and CSP and each of its dimensions

	Obs	Mean	Median	Std.Dev	Min	Max
Bank Efficiency Score	740	2.997	2.457	1.798	1.086	13.860
ESG Index	740	1.260	1.090	0.537	1.013	9.267
Environmental Index	740	3.140	1.256	4.419	1.010	20.878
Social Index	740	1.668	1.172	1.726	1.012	17.822
Governance Index	740	1.565	1.246	1.114	1.011	19.761

least directly, has little environmental impact. However, over the period studied, there is a significant increase in the performance of this dimension, with the Environmental index falling from 3.332 for 2011 to 2.292 for 2019.

In Table 7, we have presented the descriptive statistics of the variables of interest in our study that will be used to test the hypotheses formulated in Sect. 2: the bias-corrected efficiency score $\left(\hat{\hat{\theta}}\right)$ and the bias-corrected indices of ESG activities and each of their dimensions $\left(\hat{\hat{\phi}}\right)$.

5.2 Truncated regression analysis for bank efficiency

Table 8 displays the results for the truncated regression, which allows us to analyse the effect of different variables, including those related to CSP, on bank efficiency. The results presented assume that it is linearly related to the CSP and each of its dimensions. As already mentioned, to measure how efficient it is, we have used the bootstrapped bias-corrected efficiency score $\left(\hat{\hat{\theta}}\right)$, and the CSP and each of its dimensions have been measured by the ESG, Environmental, Social and Governance Indices, respectively (as detailed in Sect. 5.1). Column (1) presents the estimation results of Eq. (6), including only the bank-specific and macroeconomic control variables. In columns (2)-(4), CSP variables have been included to investigate the effect of CSP and each of its dimensions on bank efficiency.

Reviewing column (1), we can conclude that: (i) the coefficient associated with the bank's size is statistically significant, showing that the larger it is, the higher the levels of efficiency[7] are; (ii) the more revenue diversification banks have, the higher the levels of efficiency are; (iii) the better capitalized and more profitable banks are, the more efficient they are; (iv) the greater the percentage of independent directors a bank has on the board, the more inefficient it is; (v) banks with lower credit risk and with a more concentrated ownership structure are more efficient (vi) the more concentrated banking sector of a country, with a higher HHI, the less efficient the bank is; (vii) in the context of economic and inflationary expansion, banks are

[7] Remember that the higher the value of θ is, the more inefficient the bank is.

Table 8 Results of bootstrap truncated regressions for determinants of bank efficiency (linear relationship assumed between CSP and bank efficiency)

	(1)	(2)	(3)	(4)	(5)
Size	−1.213***	−1.163***	−1.325***	−1.338***	−1.222***
	[−1.382, −1.015]	[−1.335, −0.959]	[−1.514, −1.109]	[−1.539, −1.121]	[−1.398, −1.011]
Revenue Diversif	−0.041***	−0.042***	−0.042***	−0.043***	−0.042***
	[−0.053, −0.029]	[−0.055, −0.03]	[−0.056, −0.029]	[−0.056, −0.030]	[−0.055, −0.029]
Liquidity	−0.011*	−0.014*	−0.012*	−0.013*	−0.012*
	[−0.023, 0.001]	[−0.027, 0.001]	[−0.025, 0.001]	[−0.029, 0.002]	[−0.023, 0]
Return on assets	−0.122**	−0.118**	−0.175**	−0.163***	−0.122***
	[−0.169, −0.067]	[−0.166, −0.064]	[−0.244, −0.096]	[−0.225, −0.093]	[−0.172, −0.069]
NPL ratio	0.285***	0.277***	0.290***	0.277***	0.276***
	[0.181, 0.372]	[0.177, 0.359]	[0.187, 0.373]	[0.176, 0.353]	[0.174, 0.352]
Equity to assets ratio	−0.075***	−0.069***	−0.078***	−0.081***	−0.076***
	[−0.137, −0.028]	[−0.127, −0.023]	[−0.144, −0.025]	[−0.146, −0.028]	[−0.139, −0.025]
Board independence	0.028***	0.029***	0.028***	0.027***	0.029***
	[0.019, 0.037]	[0.018, 0.039]	[0.018, 0.037]	[0.018, 0.037]	[0.019, 0.039]
Board gender diversity	0.002*	0.003	0.004	0.005	0.004
	[−0.001, 0.017]	[−0.004, 0.009]	[−0.005, 0.013]	[−0.007, 0.018]	[−0.004,0.012]
Ownership structure	−6.823***	−6.557***	−7.085***	−6.416***	−6.551***
	[−10.91, −2.75]	[−10.471, −3.226]	[−11.330, −3.145]	[−10.189, −2.652]	[−10.40, −2.907]
HHI	3.168***	3.268***	4.152***	4.142***	3.956***
	[0.486, 5.713]	[0.185, 6.194]	[0.477, 7.646]	[0.482, 7.666]	[0.348, 7.082]
Real GDP growth	−0.090**	−0.111**	−0.098**	−0.102***	−0.119***
	[−0.158, −0.026]	[−0.192, −0.039]	[−0.18, −0.027]	[−0.186, −0.028]	[−0.203, −0.042]
Inflation	−0.468***	−0.454***	−0.494***	−0.502***	−0.483***
	[−0.698, −0.233]	[−0.674, −0.211]	[−0.748, −0.257]	[−0.734, −0.245]	[−0.741, −0.242]
Domestic Credit / GDP	0.023*	0.017	0.023*	0.023	0.018
	[−0.004, 0.048]	[−0.011, 0.043]	[−0.003, 0.050]	[−0.005, 0.049]	[−0.009, 0.043]

Table 8 (continued)

	(1)	(2)	(3)	(4)	(5)
GDP per capita	1E-04***	1E-04***	1E-04***	1E-04***	1E-04***
	[1E-04, 2E-04]	[1E-04, 2E-04]	[1E-04, 2E-04]	[1E-04, 2E-04]	[1E-04, 2E-04]
ESG Index		1.981***			
		[0.792, 2.991]			
Environmental index			0.155		
			[−0.015, 0.293]		
Social index				−0.371	
				[−0.894, 0.104]	
Governance index					0.816***
					[0.248, 1.267]
Constant	9.450***	6.891***	10.75***	11.05***	9.021***
	[8.256, 10.555]	[5.936, 7.705]	[9.326, 12.059]	[9.577, 12.451]	[7.802, 10.154]
Sigma	1.753***	1.742***	1.756***	1.897***	1.745***
	[1.554, 1.884]	[1.545, 1.872]	[1.575, 1.885]	[1.685, 2.027]	[1.566, 1.876]

The table reports the estimation results for the truncated regression using algorithm II, proposed by Simar and Wilson (2007). The dependent variable of all regressions is the bootstrapped bias-corrected efficiency score obtained considering the BCC model in the first stage, with output orientation, two inputs [(I)FA, (I)ACL] and two outputs [(O)L, O(NII)]. All regressions have been estimated with 740 observations. Time Dummies are included. The number of bootstrap replications for the bias correction of DEA scores and for estimating confidence intervals (CIs) for the regression coefficients is 2000. The 95% CIs are quoted in the squared brackets. *, ** and *** indicate statistical significance at levels of 10%, 5% and 1%, respectively

more efficient; and finally, (viii) banks of higher-income countries show to be less efficient. The gender diversity of the board, the variable liquidity and the domestic credit to private sector as a percentage of GDP only influence bank efficiency to a significance level of 10%.

With regard to the effect of ESG activities, measured by the ESG Index, on bank efficiency, we can conclude that an increase in the index raises the score (the sign of the estimate of the coefficient associated with the ESG Index variable in column (2) is positive and significant for a 1% significance level). This means that the statistical evidence supports Hypothesis I which states that the worse the CSP is for a bank, the less efficient it is. These results are in line with those obtained by Belasri et al., (2020), who have found evidence that CSR has a positive impact on bank efficiency in developed countries, and Shah et al. (2019) who have found support in their study that sustainable banks are more efficient and productive. Looking at the results presented in columns (3) and (4), we cannot find statistical evidence that banks with better social and environmental practices are more efficient, since the coefficients associated with the Environmental Index and Social Index variables are not statistically significant. This means that our results do not support Hypotheses II and III of our study. However, we have found evidence that supports Hypothesis IV. With respect to column (5), we can see that the estimate of the coefficient associated with the Governance Index is positive and statistically significant. This means that banks with good governance practices are more efficient. These first results seem to support what is advocated by the Stakeholder Theory, according to which banks with the best CSP are the ones with the best levels of efficiency. However, the dimension linked to the bank's governance model seems to be the only one that contributes to that positive relationship. As suggested by Agency Theory, banks that adopt governance practices that best align the interests of shareholders and managers are the most efficient.

To analyse the validity of the hypothesis of a non-linear relationship between bank efficiency and CSP (and each of its three dimensions) [Hypothesis V], Eq. (6) has been re-estimated by additionally including the term CSP_{it}^2. The estimation results are shown in Table 9. As for column (1) in the table, we can conclude that the coefficients associated with the ESG index and its squared variables are both significant for a 5% significance level, which results in a non-linear relationship between the CSP and bank efficiency. To be more precise, based on the signals obtained for the estimates of the coefficients, we can see a U-shaped relationship between aforementioned variables, that is to say, banks with low or high CSP are the most efficient whereas those with intermediate levels of CSP are the most inefficient. These results are in line with Nollet et al. (2016) and Shabbir et al. (2020) who have also found a U-shaped relationship between CSP and financial performance. These findings allow us to reconcile the two opposing theoretical views on the relationship between CSP and bank efficiency. In favour of the Trade-Off View of ESG activities we can point to banks with low levels of CSP which invest a great deal of money in CSR activity and see their efficiency levels go down. In support of Stakeholder Theory, there is evidence that banks with high levels of CSP which invest more in ESG activities tends to improve their efficiency levels.

The results of columns (2–4) in Table 9 make us draw the same conclusion for the social and governance dimensions of ESG activities, or to put it another way, banks with low or high performance in these two dimensions are the most efficient whereas

Table 9 Results of bootstrap truncated regressions for determinants of bank efficiency (non-linear relationship assumed between CSP and bank efficiency)

	(1)	(2)	(3)	(4)
Size	−1.115***	−1.202***	−1.119***	−1.112***
	[−1.292, −0.922]	[−1.374, −0.992]	[−1.279, −0.921]	[−1.274, −0.924]
Revenue Diversification	−0.042***	−0.044***	−0.043***	−0.044***
	[−0.053, −0.03]	[−0.058, −0.031]	[−0.056, −0.03]	[−0.056, −0.03]
Liquidity	−0.019**	−0.018*	−0.019*	−0.021*
	[−0.036, −0.003]	[−0.039, 0.001]	[−0.040, 0.001]	[−0.038, 0.001]
Return on assets	−0.117***	−0.125***	−0.132***	−0.124***
	[−0.168, −0.064]	[−0.177, −0.071]	[−0.186, −0.076]	[−0.179, −0.068]
NPL ratio	0.265***	0.281***	0.293***	0.262***
	[0.166, 0.337]	[0.185, 0.359]	[0.196, 0.361]	[0.167, 0.337]
Equity to assets ratio	−0.069***	−0.072***	−0.075***	−0.072***
	[−0.124, −0.026]	[−0.129, −0.024]	[−0.135, −0.026]	[−0.132, −0.025]
Board independence	0.029***	0.031***	0.030***	0.0032**
	[0.019, 0.039]	[0.020, 0.041]	[0.018, 0.042]	[0.002, 0.004]
Board gender diversity	0.004	0.004	0.005	0.006
	[−0.005, 0.013]	[−0.005, 0.013]	[−0.007, 0.019]	[−0.008, 0.019]
Ownership structure	−6.264***	−7.414***	−6.665***	−6.116***
	[−10.037, −2.771]	[−11.109, −3.707]	[−10.987, −2.657]	[−9.913, −2.369]
HHI	3.428**	3.823**	3.726**	3.819**
	[0.008, 6.599]	[0.222, 6.948]	[0.396, 6.925]	[0.564, 6.989]
Real GDP growth	−0.111***	−0.112***	−0.111***	−0.125***
	[−0.191, −0.042]	[−0.200, −0.029]	[−0.195, −0.035]	[−0.209, −0.046]
Inflation	−0.555***	−0.559***	−0.576***	−0.568***
	[−0.837, −0.271]	[−0.838, −0.292]	[−0.862, −0.283]	[−0.847, −0.276]
Domestic Credit / GDP	0.014	0.022	0.013	0.014
	[−0.013, 0.038]	[−0.005, 0.047]	[−0.014, 0.042]	[−0.013, 0.038]
GDP per capita	9E-05**	1E-04***	1E-04**	1E-04**
	[1E-04, 2E-04]	[1E-04, 2E-04]	[1E-04, 2E-04]	[1E-04, 2E-04]
ESG Index	6.338***			
	[3.549, 9.563]			
ESG Index squared	−0.572***			
	[−1.114, −0.228]			
Environmental index		0.957		
		[−0.653, 1.567]		
Environmental index squared		−0.015		
		[−0.062, 0.325]		
Social index			1.210***	
			[0.475, 1.846]	
Social index squared			−0.088***	
			[−0.132, −0.029]	
Governance index				2.236***
				[1.04, 3.343]

Table 9 (continued)

	(1)	(2)	(3)	(4)
Governance index squared				−0.095***
				[−0.19, −0.029]
Constant	3.093***	5.9322***	3.523***	9.022***
	[2.593, 3.538]	[4.366, 5.958]	[2.997, 3.979]	[7.314, 9.584]
Sigma	1.769***	1.859***	1.861***	1.854***
	[1.568, 1.889]	[1.648, 1.985]	[1.658, 1.986]	[1.656, 1.974]

idem Table 8

those with intermediate performance levels in the aforesaid scenario are the least efficient. These figures imply that if a bank decides to invest in socially responsible practices, it will have to do so in a sustained way to obtain high levels of performance, as only for these levels is the investment transformed into efficiency gains. As stated by Birindelli et al. (2015), stable and fair relationships between employees and management lead to higher personal satisfaction and loyalty, contributing to an increase in corporate efficiency. Banks that sustainably engage with the local communities in which they operate can build positive publicity that results in increased demand for their products and services, thus increasing the bank's efficiency.

The environmental dimension of ESG activities continues to prove insignificant as an explanation for the efficiency of banks. These results corroborate the arguments of Finger et al. (2018), according to which, banks in developed countries have already optimized their processes in such a way that additional environmental measures do not result in efficiency gains.

Figure 3 shows the relationship between a bank's inefficiency and ESG performance, as well as its social and governance dimensions for a bank representative of our sample (average values). We can conclude that a bank's inefficiency is at its maximum when the ESG index value is 5.54, when the Social index value is 6.88 and the Governance index value is 11.77. In addition, the U-shaped curve is less pronounced when the Social index is related to the bank's efficiency.

5.3 Robustness analysis

Several studies have highlighted that financial factors are crucial for explaining why CSR practices are adopted. The most efficient banks have, a priori, more access to these financial resources. Based on this idea, it is reasonable to assume that bank efficiency can influence CSP by itself, resulting in a possible bidirectional relationship between both. This means that an endogeneity problem arises when we estimate Eq. (6), given the simultaneity between the bank's efficiency and the CSP. To overcome this, and by using possible omitted variables, we have run the System Generalized Method of Moments (GMM), proposed by Arellano & Bover (1995) to re-estimate Eq. (6) including the term CSP_{it}^2 due to the evidence of there being a non-linear relationship. This method combines the first differences in our regression equation with the level form, reducing any biases and imprecision associated with the first-difference GMM. We

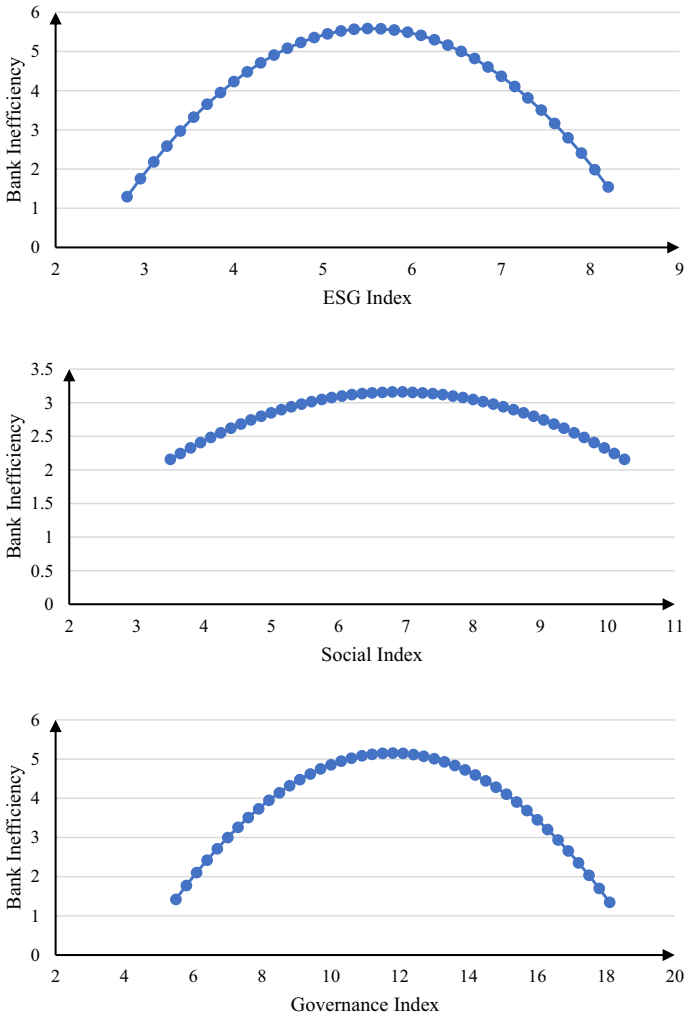

Fig. 3 Relationship between Bank inefficiency and ESG, Social and Governance indexes for a representative bank

have employed the two-step GMM estimator, instead one-step GMM estimator, with Windmeijer (2005) corrected standard errors, because it is more efficient. To satisfy the instruments' validity, we have tested for over-identifying restrictions using Hansen's (1982) *J* test and the Arellano-Bond test to check for first- AR(1) and second-order autocorrelation AR(2).

The results presented in Table 10 are free from any endogeneity issues and using dynamic GMM has also helped us to control for persistence. To test the non-linear relationship between bank efficiency and CSP (and each of its components), we use the U-shape test developed by Lind and Mehlum (2010), which is more adequate than the simple analysis of the significance of the coefficients associated with the variables CSP_{it} and CSP_{it}^2. The results obtained have only confirmed the non-linear relationship

Table 10 Robustness test for assumed non-linear relationship between CSP and bank efficiency

	(1)	(2)	(3)	(4)
L.Dependent variable	0.597***	0.575***	0.528***	0.583***
	(0.100)	(0.098)	(0.126)	(0.095)
Size	−0.198**	−0.305*	−0.301**	−0.227*
	(0.093)	(0.200)	(0.138)	(0.151)
Revenue diversification	0.003	0.004	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.002)
Liquidity	−0.009	−0.008	−0.008	−0.009
	(0.009)	(0.009)	(0.009)	(0.01)
Return on assets	0.091**	0.081**	0.081**	0.086*
	(0.049)	(0.052)	(0.054)	(0.047)
NPL ratio	−0.039	−0.031	−0.03	−0.045
	(0.051)	(0.045)	(0.044)	(0.041)
Equity to assets ratio	−0.002	−0.005	0.002	−0.002
	(0.011)	(0.01)	(0.012)	(0.01)
	(1)	(2)	(3)	(4)
Board independence	−0.004***	−0.007***	−0.005**	−0.005**
	(0.002)	(0.003)	(0.003)	(0.002)
Board gender diversity	0.003	0.003	0.001	0.002
	(0.004)	(0.005)	(0.004)	(0.004)
Ownership structure	−0.334**	−0.365**	−0.218**	−0.199**
	(0.156)	(0.153)	(0.103)	(0.105)
HHI	0.935	1.687	0.905	0.343
	(2.603)	(3.158)	(2.801)	(2.961)
Real GDP growth	0.020*	0.012	0.014	0.017
	(0.015)	(0.009)	(0.011)	(0.01)
Inflation	−0.037	−0.036	−0.019	−0.038
	(0.051)	(0.045)	(0.038)	(0.046)
Domestic Credit / GDP	−0.011*	−0.009**	−0.012**	−0.013**
	(0.006)	(0.005)	(0.006)	(0.006)
GDP per capita	−2E-05*	−2E-05*	−2E-05*	−3E-05**
	(1E-05)	(1E-05)	(1E-05)	(1E-05)
ESG index	0.932***			
	(0.331)			
ESG index squared	−0.115**			
	(0.048)			
Environmental index		0.057		
		(0.055)		
Environmental index squared		−0.001		
		(0.002)		
Social index			0.253*	
			(0.149)	

Table 10 (continued)

	(1)	(2)	(3)	(4)
Social index squared			−0.017	
			(0.012)	
Governance index				0.105
				(0.219)
Governance index squared				0.002
				(0.027)
Constant	5.150**	6.806**	7.22***	6.791***
	(2.204)	(3.033)	(2.368)	(2.439)
U-Shape test	2,08**	Extremum outside interval	1.22	Extremum outside interval
p-value [U-Shape test]	0.019		0.111	
Turning point	4.044		7.444	
95% Fieller interval for extreme point	[3.173; 7.838]		[-∞; +∞]	
Number of instrumental variables	57	57	57	57
F-Test	195.31***	157.32***	149.65**	185.63***
AR(1) Test	−3.041**	−2.363**	−2.381**	−2.449**
AR(2) Test	−0.752	0.089	0.107	0.023
Hansen's J Test	25.62	24.53	26.00	27.23
p-value [Hansen's J Test]	0.220	0.175	0.236	0.293

All the regressions have been estimated with 632 observations. The dependent variable of all the regressions is the bootstrapped bias-corrected efficiency score obtained considering the BCC model in the first stage, with output orientation. Year Dummies are included, but not reported. The U-shape test is based on Lind and Mehlum (2010) and "Extremum outside interval" means that the extremum point (i.e. the turning point) is outside the interval, then we cannot reject the null hypothesis of a monotone relationship. Robust standard errors are reported in parentheses below their coefficient estimates. *, ** and *** indicate statistical significance at levels of 10%, 5% and 1%

between ESG index activities and the bank's efficiency. For each individual component of CSP the same conclusion could not be draw. Although the turning point for the social component takes a reasonable value, the Lind and Mehlum test did not allow us to conclude that there is a U-shaped relationship between CSP and bank efficiency.

Given these results, we have re-estimated the model excluding the quadratic terms from the ESG, Environmental, Social and Governance indices. The results can be seen in Table 11 and indicate that there is a significant and positive linear relationship between the efficiency of a bank and the CSP, while at the disaggregated level, a good performance in social components and governance improves the bank's efficiency.

In our analysis, the use of alternative models to the BCC model, such as the SBM and DDF models, was also considered. It was found that the rankings of the efficiency scores of these alternative models were very similar to those of the BCC model, reinforcing the use of this model in the following steps.

Table 11 Robustness test for assumed linear relationship between CSP and bank efficiency

	(1)	(2)	(3)	(4)
L.Dependent variable	0.591***	0.574***	0.584***	0.583***
	(0.098)	(0.098)	(0.151)	(0.093)
Size	−0.227**	−0.304**	−0.324**	−0.228**
	(0.138)	(0.153)	(0.164)	(0.114)
Revenue diversification	0.003	0.004	0.004	0.003
	(0.002)	(0.003)	(0.003)	(0.002)
Liquidity	−0.009	−0.008	−0.009	−0.009
	(0.01)	(0.009)	(0.009)	(0.009)
Return on assets	0.086*	0.078	0.089*	0.086*
	(0.047)	(0.051)	(0.051)	(0.046)
NPL ratio	−0.045	−0.028	−0.036	−0.044
	(0.041)	(0.043)	(0.042)	(0.041)
Equity to assets ratio	−0.002	−0.005	−0.001	−0.002
	(0.010)	(0.010)	(0.01)	(0.01)
Board independence	−0.005**	−0.007*	−0.005**	−0.005**
	(0.002)	(0.004)	(0.002)	(0.002)
Board gender diversity	0.002	0.003	0.002	0.002
	(0.004)	(0.005)	(0.004)	(0.004)
Ownership structure	−0.222**	−0.359**	−0.392***	−0.292**
	(0.102)	(0.176)	(0.127)	(0.127)
HHI	0.343	1.725	1.725	0.359
	(2.961)	(3.137)	(3.137)	(2.871)
Real GDP growth	0.017	0.012	0.012	0.017
	(0.010)	(0.009)	(0.009)	(0.01)
Inflation	−0.038	−0.036	−0.036	−0.038
	(0.046)	(0.041)	(0.041)	(0.046)
Domestic Credit / GDP	−0.013**	−0.009*	−0.009*	−0.013**
	(0.006)	(0.005)	(0.005)	(0.006)
GDP per capita	−3E-05**	−2E-05*	−2E-05*	−3E-05**
	(1E-05)	(1E-05)	(1E-05)	(1E-05)
ESG index	0.345**			
	(0.179)			
Environmental index		0.045		
		(0.041)		
Social index			0.146**	
			(0.074)	
Governance index				0.118**
				(0.060)
Constant	6.561***	6.816***	6.816***	6.781***
	(2.307)	(2.870)	(2.87)	(2.456)
Number of instrumental variables	53	53	53	53
F-Test	165.01***	143.82***	145.36***	175.36***
AR(1) Test	−2.458**	−2.362**	−2.327**	−2.472**
AR(2) Test	−0.064	0.096	0.166	0.014

Table 11 (continued)

	(1)	(2)	(3)	(4)
Hansen's J Test	24,26	22,45	24.00	25.23
p-value [Hansen's J Test]	0.284	0.199	0.271	0.334

All the regressions have been estimated with 632 observations. The dependent variable of all the regressions is the bootstrapped bias-corrected efficiency score obtained considering the BCC model in the first stage, with output orientation. Year Dummies are included, but not reported. Robust standard errors are reported in parentheses below their coefficient estimates. *, ** and *** indicate statistical significance at levels of 10%, 5% and 1%

6 Conclusion

The 2008 financial crisis and the need for many governments to bail out troubled banks called for the banking sector to adopt better social and environmental practices based on responsible governance principles. As a result, banks have increased their social responsibility practices, reinforcing their credibility with a range of stakeholders. Since then, several investigations have studied the effects of CRS activity on bank performance, namely on profitability and its market value. However, very few studies have looked into the effects of CRS activity on bank efficiency.

Our research has investigated the relationship between CSP and bank efficiency using a sample of listed European banks for the period 2011–2019. To measure bank efficiency, we have used the well-known nonparametric DEA technique, under the variable returns to scale hypothesis (BCC model). The performance of CRS activity and its three dimensions, namely, environmental, social and governance, has been estimated using a DEA model without explicit inputs and a set of ten indicators extracted from the Thomson Reuters Eikon Asset 4 ESG database. To study the relationship between bank efficiency and CSP and other control variables, algorithm II of the two-stage procedure proposed by Simar and Wilson (2007) has been used.

The main conclusions of our study for the proposed efficiency model indicate that, in general, European banks present low levels of efficiency, scoring around 50% for pure technical efficiency. It was also found that, in the period under analysis, European banking shows good levels of ESG performance, with emphasis on the social and governance components.

When it comes to European banks, our results also point towards a U-shaped relationship between CSP and efficiency, meaning that if they have intermediate levels of CSP they are less efficient, whereas if they have either low or high levels of CRS activity, they produce better levels of efficiency. These results, in line with those obtained by Nollet et al. (2016), enable us to reconcile the Neoclassical View with the Stakeholder Theory regarding the relationship between CSP and bank efficiency.

At the disaggregated level, the same conclusion has been drawn regarding the social and governance dimensions of CSR activity. Our results support the paradigm of the triple bottom line for European banking institutions, with the exception of the environmental dimension. This dimension of CRS activity does not improve bank efficiency, thus refuting the postulate of the Stakeholder Theory. Our results are similar to those obtained by Finger et al. (2018) for banks from developed countries in the sense that these are low-polluting organizations and have already optimized their operations from an environmental point of view. However, activity in this pillar needs to continue be proactive in favouring financing environmentally sustainable projects and activities, in line with the recommendations of European regulators.

Our results also have strong implications for regulators, policymakers, bank managers and investors to acknowledge and adopt appropriate measures in order to improve the financial and sustainability performance of banks. First, our results support the changes in the EU Regulatory Taxonomy that lead banks to align their activities and strategies with the Sustainable Development Goals. In addition, regulators should reinforce the disclosure requirements on banks' CSR activities, leading investors to take better-informed positions, increasing the overall efficiency of financial markets. Second, although bank managers are often driven by short-term results, the adoption of sustainable practices in the environmental, social and governance domains will allow, in the long term, to mitigate the legal and regulatory risk imposed by the various European regulatory reform initiatives. Finally, our results indicate that good practices in the different dimensions of the CSR activity have a positive impact on the bank's efficiency if they are implemented in a sustained way.

These results are particularly relevant in a context of pandemic crisis, characterized by an increase in credit risk and operating costs, where banking must play an essential role in economic recovery. We hope that this new context will not affect the banks' corporate social performance and consequently their bank efficiency.

This study has some limitations. Firstly, the sample has only considered listed banks. In future, this analysis could be extended to unlisted banks, which would entail developing new indicators to measure performance in all dimensions of ESG activities. Secondly, the analysis carried out should be corroborated with a new framework by using new parametric and non-parametric approaches such as the stochastic frontier approach and the analytical hierarchical process.

Appendix

See Table 12.

Table 12 Bank ESG activities and each of their dimension indices and bias-corrected indices (means) by year based on DEA-WEI model

Year	ESG Index			Environmental Index			Number of banks
	Efficiency Score	Bias-corrected efficiency score	% Efficient DMUs	Efficiency Score	Bias-corrected efficiency score	% Efficient DMUs	
2011	1.241	1.266	43.06	3.298	3.332	6.94	72
2012	1.306	1.333	44.44	3.091	3.122	9.72	72
2013	1.299	1.326	38.36	3.350	3.384	8.22	73
2014	1.237	1.260	33.78	3.852	3.891	8.11	74
2015	1.213	1.237	31.65	2.981	3.012	6.33	79
2016	1.217	1.243	33.73	3.239	3.272	6.02	83
2017	1.194	1.224	36.36	2.988	3.018	9.09	88
2018	1.247	1.276	32.41	3.120	3.152	3.70	108
2019	1.167	1.197	34.07	2.267	2.292	4.40	91
2011–2019	1.233	1.260	36.08	3.108	3.140	6.76	740
Year	Social Index			Governance Index			Number of banks
	Efficiency Score	Bias-corrected efficiency score	% Efficient DMUs	Efficiency Score	Bias-corrected efficiency score	% Efficient DMUs	
2011	1.711	1.731	16.67	1.481	1.499	6.94	72
2012	1.830	1.850	9.72	1.611	1.631	9.72	72
2013	1.674	1.692	9.59	1.678	1.702	6.85	73
2014	1.726	1.745	14.86	1.489	1.508	10.81	74
2015	1.723	1.743	10.13	1.542	1.559	12.66	79
2016	1.684	1.704	8.43	1.493	1.512	9.64	83
2017	1.623	1.644	9.09	1.509	1.531	6.82	88
2018	1.580	1.601	12.04	1.618	1.640	9.26	108
2019	1.372	1.393	13.19	1.472	1.495	6.59	91
2011–2019	1.647	1.668	11.49	1.544	1.565	8.78	740

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

References

Ambec S, Cohen MA, Elgie S, Lanoie P (2013) The porter hypothesis at 20: Can environmental regulation enhance innovation and competitiveness? Rev Environ Econ Policy 7(1):2–22. https://doi.org/10.1093/reep/res016

Arellano M, Bover O (1995) Another look at the instrumental variable estimation of error-components models. J Econom 68(1):29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Avkiran NK (2015) An illustration of dynamic network DEA in commercial banking including robustness tests. Omega 55:141–150. https://doi.org/10.1016/j.omega.2014.07.002

Azmi W, Hassan MK, Houston R, Karim MS (2021) ESG activities and banking performance: international evidence from emerging economies. J Int Finan Markets Inst Money 70:101277. https://doi.org/10.1016/j.intfin.2020.101277

Bace E, Ferreira A (2020) Regulation's influence on EU banking efficiency: AN evaluation post crisis. Cogent Econ Finance 8(1):1838735. https://doi.org/10.1080/23322039.2020.1838735

Banker RD, Charnes A, Cooper WW (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. Manage Sci 30(9):1078–1092. https://doi.org/10.1287/mnsc.30.9.1078

Barnett ML, Salomon RM (2012) Does it pay to be really good? Addressing the shape of the relationship between social and financial performance. Strateg Manag J 33(11):1304–1320. https://doi.org/10.1002/smj.1980

Barros CP, Chen Z, Liang QB, Peypoch N (2011) Technical efficiency in the Chinese banking sector. Econ Model 28(5):2083–2089. https://doi.org/10.1016/j.econmod.2011.04.003

Bătae OM, Dragomir VD, Feleagă L (2021) The relationship between environmental, social, and financial performance in the banking sector: a European study. J Clean Prod 290:125791. https://doi.org/10.1016/j.jclepro.2021.125791

Belasri S, Gomes M, Pijourlet G (2020) Corporate social responsibility and bank efficiency. J Multinatl Financ Manag 54:100612. https://doi.org/10.1016/j.mulfin.2020.100612

Belu C, Manescu C (2013) Strategic corporate social responsibility and economic performance. Appl Econ 45(19):2751–2764. https://doi.org/10.1080/00036846.2012.676734

Ben Rhouma A, Francoeur C, Robin G (2014) International corporate sustainability barometer 2012: sustainability management in France. In: Schaltegger ES, Windolph SE, Harms D, Hörisch J (eds) Corporate Sustainability in International Comparison State of Practice Opportunities and Challenges. Springer, Berlin, pp 69–91

Birindelli G, Ferretti P, Intonti M, Iannuzzi AP (2015) On the drivers of corporate social responsibility in banks: evidence from an ethical rating model. J Manage Governance 19(2):303–340. https://doi.org/10.1007/s10997-013-9262-9

Bowlin WF (1998) Measuring performance: an introduction to data envelopment analysis (DEA). J Cost Anal 15(2):3–27. https://doi.org/10.1080/08823871.1998.10462318

Branco MC, Rodrigues LL (2006) Corporate social responsibility and resource-based perspectives. J Bus Ethics 69(2):111–132. https://doi.org/10.1007/s10551-006-9071-z

Brown LD, Caylor ML (2006) Corporate governance and firm valuation. J Account Public Policy 25(4):409–434. https://doi.org/10.1016/j.jaccpubpol.2006.05.005

Buallay A, Fadel SM, Alajmi J, Saudagaran S (2021) Sustainability reporting and bank performance after financial crisis: evidence from developed and developing countries. Compet Rev: Int Bus J 31(4):747–770. https://doi.org/10.1108/CR-04-2019-0040

Capelle-Blancard G, Petit A (2017) The weighting of CSR dimensions: one size does not fit all. Bus Soc 56(6):919–943. https://doi.org/10.1177/0007650315620118

Carroll AB (1991) The pyramid of corporate social responsibility: toward the moral management of organizational stakeholders. Bus Horiz 34(4):39–48. https://doi.org/10.1016/0007-6813(91)90005-G

Charnes A, Cooper WW, Rhodes E (1978) Measuring the efficiency of decision making units. Eur J Oper Res 2(6):429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Charnes A, Cooper WW, Lewin AY, Seiford LM (1994) Data envelopment analysis: theory, methodology, and applications. Springer. https://doi.org/10.1007/978-94-011-0637-5

Christopoulos AG, Dokas IG, Katsimardou S, Spyromitros E (2020) Assessing banking sectors' efficiency of financially troubled Eurozone countries. Res Int Bus Financ 52:101121. https://doi.org/10.1016/j.ribaf.2019.101121

Cornett MM, Erhemjamts O, Tehranian H (2016) Greed or good deeds: an examination of the relation between corporate social responsibility and the financial performance of U.S. commercial banks around the financial crisis. J Bank Finance 70:137–159. https://doi.org/10.1016/j.jbankfin.2016.04.024

Coulson AB (2009) How should banks govern the environment? Challenging the construction of action versus veto. Bus Strateg Environ 18(3):149–161. https://doi.org/10.1002/bse.584

Crane A, Henriques I, Husted BW, Matten D (2017) Measuring corporate social responsibility and impact: enhancing quantitative research design and methods in business and society research. Bus Soc 56(6):787–795. https://doi.org/10.1177/0007650317713267

Eccles RG, Ioannou I, Serafeim G (2014) The impact of corporate sustainability on organizational processes and performance. Manage Sci 60(11):2835–2857

Esteban-Sanchez P, de la Cuesta-Gonzalez M, Paredes-Gazquez JD (2017) Corporate social performance and its relation with corporate financial performance: international evidence in the banking industry. J Clean Prod 162:1102–1110. https://doi.org/10.1016/j.jclepro.2017.06.127

Fijalkowska J, Zyznarska-Dworczak B, Garsztka P (2018) Corporate social-environmental performance versus financial performance of banks in central and Eastern European countries. Sustainability 10(3):772. https://doi.org/10.3390/su10030772

Finger M, Gavious I, Manos R (2018) Environmental risk management and financial performance in the banking industry: a cross-country comparison. J Int Finan Markets Inst Money 52:240–261. https://doi.org/10.1016/j.intfin.2017.09.019

Fombrun CJ (2005) A world of reputation research, analysis and thinking—building corporate reputation through CSR Initiatives: evolving standards. Corp Reput Rev 8(1):7–12. https://doi.org/10.1057/palgrave.crr.1540235

Forgione AF, Laguir I, Staglianò (2020) Effect of corporate social responsibility scores on bank efficiency: the moderating role of institutional context. Corp Soc Responsib Environ Manag 27(5):2094–2106. https://doi.org/10.1002/csr.1950

Freeman RE (1984) Strategic management: a stakeholder approach. Pitman, Boston, MA, USA

Friedman M (1970) A friedman doctrine—the social responsibility of business is to increase its profits. The New York Times Magazine, 32–33

Gallego-Sosa C, Gutiérrez-Fernández M, Fernández-Torres Y, Nevado-Gil MT (2021) Corporate social responsibility in the European banking sector: commitment to the 2030 Agenda and its relationship with gender diversity. Sustainability 13:1731. https://doi.org/10.3390/su13041731

Gao Y (2009) Corporate social performance in China: evidence from large companies. J Bus Ethics 89(1):23–35. https://doi.org/10.1007/s10551-008-9982-y

Gordini N, Rancati E (2017) Gender diversity in the Italian boardroom and firm financial performance. Manag Res Rev 40(1):75–94. https://doi.org/10.1108/MRR-02-2016-0039

Graves SB, Waddock SA (1999) A Look at the financial-social performance nexus when quality of management is held constant. Int J Value-Based Manag 12(1):87–99. https://doi.org/10.1023/A:1007770406555

Greenbaum S, Thakor A (2007) Contemporary Financial Intermediation—2nd Edition 2nd edn. https://www.elsevier.com/books/contemporary-financial-intermediation/greenbaum/978-0-08-047681-0

Grmanová E, Ivanová E (2018) Efficiency of banks in Slovakia: measuring by DEA models. J Int Stud 11(1):257–272. https://doi.org/10.14254/2071-8330.2018/11-1/20

Hansen LP (1982) Large sample properties of generalized method of moments estimators. Econometrica 50(4):1029–1054. https://doi.org/10.2307/1912775

Hart SL (1995) A natural-resource-based view of the firm. Acad Manag Rev 20(4):986–1014. https://doi.org/10.5465/amr.1995.9512280033
Hillman AJ, Keim GD (2001) Shareholder value, stakeholder management, and social issues: What's the bottom line? Strateg Manag J 22(2):125–139
Islam ZM, Ahmed SU, Hasan I (2012) Corporate social responsibility and financial performance linkage: evidence from the banking sector of Bangladesh. J Organ Manag 1(1):14–21
Izquierdo RJS, Vicedo JC (2009) La responsabilidad social empresarial en el contexto de crisis: repercusión en las sociedades cooperativas. *CIRIEC - España*. Revista De Econ Públ, Soc y Coop 65:7–32
Jenkins L, Anderson M (2003) A multivariate statistical approach to reducing the number of variables in data envelopment analysis. Eur J Oper Res 147(1):51–61. https://doi.org/10.1016/S0377-2217(02)00243-6
Jensen MC, Meckling WH (1976) Theory of the firm: Managerial behavior, agency costs and ownership structure. J Financ Econ 3(4):305–360. https://doi.org/10.1016/0304-405X(76)90026-X
Jiraporn P, Chintrakarn P (2013) How do powerful CEOs view corporate social responsibility (CSR)? An empirical note. Econ Lett 119(3):344–347. https://doi.org/10.1016/j.econlet.2013.03.026
Jo H, Kim H, Park K (2015) Corporate environmental responsibility and firm performance business. Ethics 131:257–284. https://doi.org/10.1007/s10551-014-2276-7
Lahouel BB, Zaied YB, Song Y, Yang G (2021) Corporate social performance and financial performance relationship: a data envelopment analysis approach without explicit input. Financ Res Lett 39:101656. https://doi.org/10.1016/j.frl.2020.101656
Lovell CAK, Pastor JT (1999) Radial DEA models without inputs or without outputs. Eur J Oper Res 118(1):46–51. https://doi.org/10.1016/S0377-2217(98)00338-5
Luo Y, Bi G, Liang L (2012) Input/output indicator selection for DEA efficiency evaluation: an empirical study of Chinese commercial banks. Expert Syst Appl 39(1):1118–1123. https://doi.org/10.1016/j.eswa.2011.07.111
Mateev M, Bachvarov P (2021) Regulation, ownership and bank performance in the MENA region: evidence for islamic and conventional banks. Emerg Mark Rev 47:100789. https://doi.org/10.1016/j.ememar.2020.100789
Mattingly JE (2017) Corporate social performance: a review of empirical research examining the corporation-society relationship using kinder, lydenberg, domini social ratings data. Bus Soc 56(6):796–839. https://doi.org/10.1177/0007650315585761
Miralles-Quirós MM, Miralles-Quirós JL, Redondo Hernández J (2019) ESG Performance and shareholder value creation in the banking industry: international differences. Sustainability 11(5):1404. https://doi.org/10.3390/su11051404
Neitzert F, Petras M (2019) *Corporate social responsibility and bank risk* (SSRN Scholarly Paper. J Multinatl Financ Manag 49:35–53
Neves MED, Gouveia MDC, Proença CAN (2020) European bank's performance and efficiency. J Risk Financ Manag 13(4):67. https://doi.org/10.3390/jrfm13040067
Nollet J, Filis G, Mitrokostas E (2016) Corporate social responsibility and financial performance: a non-linear and disaggregated approach. Econ Model 52:400–407. https://doi.org/10.1016/j.econmod.2015.09.019
Paltrinieri A, Dreassi A, Migliavacca M, Piserà S (2020) Islamic finance development and banking ESG scores: evidence from a cross-country analysis. Res Int Bus Financ 51:101100. https://doi.org/10.1016/j.ribaf.2019.101100
Pérez A, Martínez P, Rodríguez del Bosque I (2013) The development of a stakeholder-based scale for measuring corporate social responsibility in the banking industry. Serv Bus 7(3):459–481. https://doi.org/10.1007/s11628-012-0171-9
Phung QT, Van Vu H, Tran HP (2022) Do non-performing loans impact bank efficiency? Financ Res Lett 46:102393. https://doi.org/10.1016/j.frl.2021.102393
Porter ME, Kramer MR (2011) Creating shared value. Harv Bus Rev 89(1/2):78–92
Porter ME, van der Linde C (1995) Toward a new conception of the environment-competitiveness relationship. J Econ Perspect 9(4):97–118
Post JE, Preston LE, Sauter-Sachs S (2002) Redefining the corporation: stakeholder management and organizational wealth. Stanford University Press

Radojicic M, Savic G, Jeremic V (2018) Measuring the efficiency of banks: the bootstrapped I-distance GAR DEA approach. Technol Econ Dev Econ 24(4):1581–1605. https://doi.org/10.3846/tede.2018.3699

Rehman R, Zhang J, Naseem MA, Ahmed MI, Ali R (2020) Board independence and Chinese banking efficiency: a moderating role of ownership restructuring. Eurasian Bus Rev. https://doi.org/10.1007/s40821-020-00155-9

Řepková I (2014) Efficiency of the czech banking sector employing the DEA window analysis approach. Procedia Econ Finance 12:587–596. https://doi.org/10.1016/S2212-5671(14)00383-9

Russo MV, Fouts PA (1997) A resource-based perspective on corporate environmental performance and profitability. Acad Manag J 40(3):534–559. https://doi.org/10.2307/257052

Shabbir MS, Aslam E, Irshad A, Bilal K, Aziz S, Abbasi BA, Zia S (2020) Nexus between corporate social responsibility and financial and non-financial sectors' performance: a non-linear and disaggregated approach. Environ Sci Pollut Res 27(31):39164–39179. https://doi.org/10.1007/s11356-020-09972-x

Shah AA, Wu D, Korotkov V (2019) Are sustainable banks efficient and productive? A data envelopment analysis and the malmquist productivity index analysis. Sustainability 11(8):2398. https://doi.org/10.3390/su11082398

Shakil MH, Mahmood N, Tasnia M, Munim ZH (2019) Do environmental, social and governance performance affect the financial performance of banks? A cross-country study of emerging market banks. Manag Environ Qual: Int J 30(6):1331–1344. https://doi.org/10.1108/MEQ-08-2018-0155

Shen CH, Wu MW, Chen TH, Fange H (2016) To engage or not to engage in corporate social responsibility: empirical evidence from global banking sector. Econ Model 55(2016):207–225. https://doi.org/10.1016/j.econmod.2016.02.007

Sila I, Cek K (2017) The impact of environmental, social and governance dimensions of corporate social responsibility on economic performance: Australian evidence. Procedia Comput Sci 120:797–804. https://doi.org/10.1016/j.procs.2017.11.310

Simar L, Wilson PW (1998) Sensitivity analysis of efficiency scores: how to bootstrap in nonparametric frontier models. Manage Sci 44(1):49–61

Simar L, Wilson PW (2000) A general methodology for bootstrapping in non-parametric frontier models. J Appl Stat 27(6):779–802. https://doi.org/10.1080/02664760050081951

Simar L, Wilson PW (2007) Estimation and inference in two-stage, semi-parametric models of production processes. J Econom 136(1):31–64. https://doi.org/10.1016/j.jeconom.2005.07.009

Simpson WG, Kohers T (2002) The link between corporate social and financial performance: evidence from the banking industry. J Bus Ethics 35(2):97–109. https://doi.org/10.1023/A:1013082525900

Soana MG (2011) The relationship between corporate social performance and corporate financial performance in the banking sector. J Bus Ethics 104(1):133. https://doi.org/10.1007/s10551-011-0894-x

Staub RB, da Silva E, Souza G, Tabak BM (2010) Evolution of bank efficiency in Brazil: a DEA approach. Eur J Op Res 202(1):204–213. https://doi.org/10.1016/j.ejor.2009.04.025

Titko J, Stankevičienė J, Lāce N (2014) Measuring bank efficiency: DEA application. Technol Econ Dev Econ 20(4):739–757. https://doi.org/10.3846/20294913.2014.984255

Wagner M, Phu NV, Azomahou T, Wehrmeyer W (2002) The relationship between the environmental and economic performance of firms: an empirical analysis of the European paper industry. Corp Soc Responsib Environ Manag 9(3):133–146. https://doi.org/10.1002/csr.22

Wang Q, Dou J, Jia S (2016) A meta-analytic review of corporate social responsibility and corporate financial performance: the moderating effect of contextual factors. Bus Soc 55(8):1083–1121. https://doi.org/10.1177/0007650315584317

Windmeijer F (2005) A finite sample correction for the variance of linear efficient two-step GMM estimators. J Econom 126(1):25–51. https://doi.org/10.1016/j.jeconom.2004.02.005

Wood DJ (1991) Corporate social performance revisited. Acad Manag Rev 16(4):691–718. https://doi.org/10.2307/258977

Wu MW, Shen C-H (2013) Corporate social responsibility in the banking industry: motives and financial performance. J Bank Finance 37(9):3529–3547. https://doi.org/10.1016/j.jbankfin.2013.04.023

Wu MW, Shen CH, Chen TH (2017) Application of multi-level matching between financial performance and corporate social responsibility in the banking industry. Rev Quant Financ Acc 49:29–63. https://doi.org/10.1007/s11156-016-0582-0

Xie J, Nozawa W, Yagi M, Fujii H, Managi S (2019) Do environmental, social, and governance activities improve corporate financial performance? Bus Strateg Environ 28(2):286–300. https://doi.org/10.1002/bse.2224

Authors and Affiliations

Maria Celia López-Penabad[1,4] · Ana Iglesias-Casal[2,4] · José Fernando Silva Neto[3] · José Manuel Maside-Sanfiz[1,4]

Maria Celia López-Penabad
celia.lopez@usc.es

José Fernando Silva Neto
jose.neto@islagaia.pt

José Manuel Maside-Sanfiz
josemanuel.maside@usc.es

[1] Department of Finance and Accounting, University of Santiago de Compostela, Santiago de Compostela, Spain

[2] Department of Quantitative Economics, University of Santiago de Compostela, Santiago de Compostela, Spain

[3] Department of Management, ISLA–Instituto Politécnico de Gestão e Tecnologia, Vila Nova de Gaia, Portugal

[4] ECOBAS Research Center, Vigo, Spain