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Corporate Social Responsibility and Operational Inefficiency: A Dynamic Approach

Encarna Guillamon-Saorin [1], Magdalena Kapelko [2,*] and Spiro E. Stefanou [3,4]

1 Department of Business Administration, Universidad Carlos III de Madrid, Calle Madrid 126, 28903 Getafe, Spain; eguillam@emp.uc3m.es
2 Institute of Applied Mathematics, Department of Logistics, Wroclaw University of Economics, ul. Komandorska 118/120, 53-345 Wroclaw, Poland
3 Food and Resource Economics Department, University of Florida, Gainesville, FL 32611, USA; sstefanou@ufl.edu
4 Business Economics Group, Wageningen University, 6708 PB Wageningen, The Netherlands
* Correspondence: magdalena.kapelko@ue.wroc.pl; Tel.: +48-71-3680479

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Abstract: It is yet to be determined whether the firms' operational inefficiency is reflected on the Corporate Social Responsibility (CSR) engagement approach. This paper aims to examine this association and specifically analyzes to which of the dimensions of CSR operational inefficiency is more closely related. Operational inefficiency is assessed using Data Envelopment Analysis (DEA) via dynamic inefficiency approach that accounts for the confounding role of adjustment costs related with firms' investments. Using a sample of U.S. firms in a variety of sectors from 2004 to 2015, we find that lower dynamic inefficiency occurs in firms with a higher commitment to CSR activities. We also find that dynamic inefficiency is negatively related to firms' engagement in social and corporate governance dimensions of CSR, whereas it is positively associated with the environmental dimension of CSR. In addition, dynamically inefficient companies have higher level of CSR concerns and lower of CSR strengths. The results are robust to endogeneity issues.

Keywords: corporate social responsibility; operational inefficiency; dynamic technical inefficiency; data envelopment analysis

1. Introduction

Over the last decade, corporate actors are increasingly expected to engage in activities that are in broader interests of the environment, sustainability and society. It is more and more commonplace that larger firms staff a Chief Sustainability Officer and issue Annual Reports of Corporate and Social Responsibility (CSR). Considerable attention in the literature focuses on the financial performance of firms engaging in CSR reflecting on Corporate Social Performance (CSP). CSR relates to the "discretionary responsibilities" of the business [1] which are mostly related to corporate governance [2], while CSP's definition involves "a broad array of strategies and operating practices that a company develops in its effort to deal with and create relationships with its numerous stakeholders and the natural environment" [3]. An important feature of CSR is its voluntary nature in contrast to any regulatory device [1,4] which makes organizations allocate resources in an efficient way creating value for both the company and the society [5]. However, some governments have imposed mandatory social, environmental and ethical reporting [6]. For example, the Indian government recently decided on policy making and "CSR spending" as mandatory; this opens up a debate that if other governments should also give directives towards mandatory CSR spending [7]. Similarly, in Africa, companies are required to increase the quality of their integrating reporting [8]. In addition, within the European

Union (EU), governmental agencies are taking initiatives for endorsing and providing templates for advancement in CSR while simultaneously upholding and even praising the voluntary nature of CSR [9]. CSP can be operationalized in different ways and one approach is to interpret activities and outcomes of CSR and its dimension of environmental management as predictors of CSP [10,11]. Therefore, aggregating different aspects of CSR leads to a model representing activities that benefit society (directly or indirectly) and, thus, should be captured by CSP. CSP is consistent with firms pursuing actions that promote social good beyond the economic interest of the firm or shareholders by benefiting many stakeholders [12].

The theories underpinning CSR-related research express how CSR is interpreted from different perspectives. Classical theory supports the profit maximization from a shareholders' perspective or priority [13,14]. According to this private cost theory, socially-oriented activities represent a cost that the firm bears but without the necessarily positive impact on returns [14,15]. This early literature views CSR engagement as a resource expenditure which does not reflect on the financial performance and, therefore, only firms with excess of resources should expend on social investments [16]. This view has evolved to the stakeholder contract cost theory. Stakeholder's theory emphasizes the need of engagement with stakeholders and recognizes that different stakeholder's rights lead to full realization of organizational objectives, if fulfilled appropriately [17,18]. Under stakeholder's theory, CSR is considered to contribute to the improvement of corporate financial performance by lowering cost of managing stakeholder relationships and prioritizing the increase of financial returns [19]. Furthermore, instrumental/strategic theory focuses on the use of CSR as a strategy to achieve competitiveness and customer relationship management [20]. More recently, the business approach to CSR is integrating and closely linked to the company core business [21–23]. These theories express how an organization manages CSR practice considering different stakeholders, but, since there is no single accepted theory, perspective and definition to CSR, one can expect to find considerable variation in what constitute the theoretical and practical aspect of CSR.

In this study, we focused on the resource-based view (RBV) [24,25] linked with the stakeholder theory and which provides a different view of the corporate objectives and helps to understand the importance of CSR on the performance of the company. From a resource-based perspective, CSR can provide internal and external benefits. The internal benefits include helping a firm to develop new resources and capabilities related to know-how and corporate culture. Indeed, investing in CSR has important consequences on the creation of intangible resources and explains improvements in the operational efficiency of the company [26].

Our study addresses strategic motivations and implications of CSR engagement by investigating whether CSR reflects operational inefficiency, from the firm resource management perspective. We contend that the RBV is useful to understand why inefficient firms engage in CSR activities which reflect on the CSP. Our work complements the evidence shown for financial performance in prior research, by examining how CSR relates to relationships between output production and input demand. To this end, we establish the link between operational inefficiency and CSR by focusing on whether more inefficient firms reduce or increase their socially responsible orientation [27]. We investigate different dimensions of CSR against a measure of dynamic operational inefficiency that allows for a more comprehensive analysis of the CSR-inefficiency performance relationship.

From the efficient performance perspective, corporations should use inputs to produce outputs (and services) in the most efficient manner. Our measure of inefficiency is calculated using the operational inefficiency (or technical inefficiency) approach which involves the comparison of the observed and the optimal values of the inputs consumed and outputs produced by firms [28]. Moreover, our measure provides the indicators of firms' dynamic technical inefficiency that account for the confounding role of adjustment costs related with firms' investments, leading to unbiased measures of firm performance [29–32]. To derive the measures of dynamic inefficiency, we employ the Data Envelopment Analysis (DEA), a mathematical programming method to evaluate the relative efficiency of Decision Making Units (DMUs) with multiple inputs and outputs [33,34].

This study addresses the relationship between CSP and operational inefficiency, making several contributions to the literature on CSP and its effect on corporate performance. It contributes to the literature by demonstrating that managerial decisions to invest strategically in CSR are not only affected by managerial judgments of financial performance, as demonstrated in the previous literature, but also by operational inefficiency. In particular, we provide support to the RBV showing that more inefficient companies engage less in CSR activities, but, even when they do so, these companies take advantage of the potential costs reduction of investing on the improvement of CSR dimension of environmental performance [35]. We show that companies facing operational difficulties value the rapid benefits of environmental performance providing visibility to the company and responding to stakeholders expectations [36]. Most importantly, our most significant contribution relates to the measurement of inefficiency in the context of CSP. Given that CSP is a multidimensional concept reflecting a variety of inputs, processes and outputs which also varies across industries [11,37], we adopt a measure of dynamic inefficiency as a proxy of corporate performance to better assess and capture the essence of the link between CSP and firm performance. Our measure of inefficiency is a dynamic one, as it accounts for the firms' production and investment decisions that are linked over time and this measure has not been considered in the previous CSR research. The framework used here is based on adjustment costs, which maintains that quasi-fixed factors such as capital adjust gradually over time. In fact, Lu et al. [38] and Wei-Kang et al. [39] undertook their studies in the dynamic DEA framework. However, their methodological approaches do not account for adjustment costs.

The structure of the paper is as follows. Section 2 explains the link between CSP and operational inefficiency. Section 3 describes the underlying methodology to compute dynamic inefficiency and to run regression analysis. Section 4 presents the data and variables. The empirical results are described in Section 5. Section 6 offers concluding comments.

2. Corporate Social Responsibility and Operational Inefficiency

2.1. Corporate Social Responsibility and Corporate Performance

The benefits of CSR include reputation enhancement, insurance-like protection, shareholder wealth improvement, better risk management, improvement of market demand from customers, increase in disclosure and reporting transparency and an overall ability to access financial markets in better conditions [40–48]. The proposition is that CSR improves the firm's relationship with stakeholders which influences financial performance positively [17,49]. Moreover, CSR also improves intra-organizational interaction. Indeed, prior research argues that the adoption of labor-related CSR helps to resolve the human resources dilemmas which avoid the loss of control and may derive into economic efficiency [50]. Empirical research has attempted to establish and explain the relationship between CSP and corporate financial performance with varying degrees of success and reaching contradictory results. Although most studies support a positive association between social and financial performance [44,51–57], there is yet no clear and conclusive explanation for this association. The inconclusive results are justified by the complexity of the CSR concept and the difficulty to argue in favor of a direct causal relationship with firm performance [56]. Studies trying to shed light on the social-financial performance association have investigated omitted variables such as innovation [3,58–60], causality effects [3,11,54], moderating factors [58,61,62], mediating effect explanations [3,53,63,64], firm-specific characteristics [65–67] and corporate social irresponsibility [68,69]. In these studies, financial performance is defined in terms of stock prices, market value or accounting profitability using the firm as a unit of analysis.

Another stream of research separately investigates CSR in the context of operational inefficiency as complementary to the social-financial performance relation. The aim of these studies has been to analyze the technological and economic relations between input demand and output production while considering opportunity costs of inputs and capital investment [70]. Research analyzing the association between CSR and operational inefficiency is less abundant than that involving financial

performance and has focused mostly on three themes. The first theme addresses sector-specific analyses to understand the determinants of the relationship between CSR and operational inefficiency but considering only one dimension of CSR [27,39,71–74]. The second theme addresses the methodological challenges related to the inefficiency measurement where the social costs involved in the production of outcomes and CSR factors are considered [75,76]. The last theme focuses on the measurement of CSR using the methodologies taken from the efficiency research [77,78].

We build on this body of work by focusing on the association between CSR and firm operational inefficiency using a multidimensional measure of CSP and a dynamic measure of operational inefficiency.

2.2. Resource-Based View and Operational Inefficiency

The RBV emerged as a paradigm in strategic business planning in the 1990s. This theory argues that the source of sustainable advantage comes from developing superior capabilities and resources. Barney's article, "Firm Resources and Sustained Competitive Advantage" [24], is seen as pivotal in the emergence of the RBV. The RBV is an interdisciplinary approach representing a change in thinking [79]. The RBV is broadly related to the areas of economics, ethics, law, management, marketing, supply chain management and general business [80]. RBV refers to an organization's internal resources for organizing processes and obtaining a competitive advantage. Resources should be valuable, rare, imperfectly imitable and not substitutable to hold potential as sources of sustainable competitive advantage [24] and develop unique, firm-specific core competencies that will allow them to outperform competitors by doing things differently [81].

RBV can contribute to the analysis of CSP by offering important insights on how it relates to corporate inefficiency. RBV has been used to construct a model of "profit-maximizing" CSR [12]. The model explains how two companies may produce the same product with the only difference that one of the companies' products has a social attribute potentially valued by stakeholders. The model also contemplates the cost-benefits analysis to determine the level of resources to invest in CSR. Along this line, McWilliams et al [82] argued that engaging in social responsibility activities when these are expected to benefit the firm is a behavior that can be analyzed through the RBV lens. Indeed, firms generate sustainable competitive advantages by effectively controlling internal valuable resources and capabilities that may be difficult to imitate, and for which no perfect substitute is available [82]. Engaging in CSR can help firms to create some of these elements of differentiation from which to extract profits.

With economic resources being the means by which firms achieve their objectives and accomplish their activities, they are considered as the "basic constitutive elements out of which firms transform inputs into outputs, or generate services" [83]. However, the economic resources by themselves are not productive and need to be used by the company to perform its activities to achieve a competitive advantage [84]. Thus, as part of this analysis "abilities to assemble, integrate, and manage these bundles of resources", i.e., its capabilities [35] (p. 537), need to be considered.

Each firm has several resources and capabilities developed over time as the firm interacts with all its stakeholders and learns throughout the process [85] (p. 711). Engagement in socially responsible activities may have internal benefits like helping a firm to develop new resources and capabilities that are related to know-how and corporate culture. These resources and capabilities, acquired internally, would then lead to more efficient use of resources. In line with the RBV, a firm focusing on the more efficient use of its internal resources would benefit from engagement in CSR. This would imply that, in general, companies consider CSR engagement as the appropriate strategy to overcome the inefficiencies.

However, CSR is a type of investment that requires a firm to adopt a long-term perspective to gain its value-generating full potential [86–88]. Firms benefit more from CSR investment when the engagement is slow and consistent, and particularly when it starts with aspects of CSR that are more internal to the firm [89]. For more inefficient companies, this long-term orientation may not be attractive and, therefore, they are likely to minimize their CSR investment. In line with these arguments, we propose the following hypothesis.

Hypothesis 1 (H1). *Companies facing higher operational inefficiency are less likely to engage in CSR activities.*

Even though the engagement in CSR may not be an overall attracting investment option for more inefficient companies, as they need to dedicate their resources to overcome the existent inefficiencies, investment in specific dimensions of CSR may appear to be appealing. CSR generally satisfies all stakeholders contributing to the common good [50]. However, some dimensions of CSR provide high visibility and, therefore, more rapid benefits for corporations [90]. External CSR dimensions addressed mainly to the benefit of external stakeholders have a bigger and more immediate impact on the public's perception of the company's reputation [89]. Moreover, CSR investment can be addressed to benefit primarily also stakeholders internal to the firm, such as employees and governance. The social benefits of CSR addressed to internal stakeholders are less visible to the public. Therefore, these more immediate and visible effects of external-related CSR investments may be of higher interest to those companies that are more operationally inefficient and which situation makes it difficult to apply the long-term CSR orientation. In particular, one of the areas of social responsibility which has been linked to corporate efficiency is environmental performance [91]. Firms facing higher operational inefficiencies may invest more in environmental CSR to obtain rapid benefits, achieve visibility to improve corporate reputation and respond to stakeholders' expectations [36]. Environmental performance leads to some important management competencies (e.g., problem solving, discovering sources of inefficiency and incentive employees participation) and, thus, improving environmental management practices may reflect in general management improvement [35]. Therefore, environmental CSR activities are likely to reflect on the improvement of corporate inefficiency besides providing faster benefits than other CSR dimensions. In line with the above arguments, we propose the following hypothesis.

Hypothesis 2 (H2). *Companies facing higher operational inefficiency are more likely to engage in environmental CSR activities.*

3. Methods

3.1. The Measurement of Dynamic Inefficiency

The concept of dynamic inefficiency is based on the premise that firms' production decisions are linked over time, therefore current production choices can enhance or constrain future production opportunities. It is clear that time interdependence exists between the input consumption and output production for a production unit in consecutive periods. Recent literature seems to be in the consensus that not accounting for the dynamics of production decisions in the measures of firms' inefficiency can provide biased measures of firm performance [29,30,92,93]. Consequently, the dynamic linkages must be considered to correctly calculate inefficiency measures.

There are two broad directions to the measurement of dynamic inefficiency. The dynamic network DEA framework is an initial exploration introduced by Färe and Grosskopf [94], and extended by, among others, Tone and Tsutsui [93], Nemoto and Goto [95], Chen and Van Dalen [96], Chen [97] or Kao [98]. Essentially, the objective is to model the internal structure of firms with intermediate products or carry-over activities across multiple periods. The second main framework measuring of dynamic inefficiency is grounded on the theory of adjustment cost, historically developed by Treadway [99], Lucas [100] and Eisner and Strotz [101]. This theory posits that the changes in the level of quasi-fixed factors induced by investments in new capital are accompanied by adjustment costs which represent transaction or reorganization costs. For example, buying a new machine usually entails training of workers, installing this machine among other frictions in adjustment. Hence, the tradeoff exists between current production and investments for future production potential that comes with the increased capital stock. The dynamic inefficiency framework, initiated by Silva and Stefanou [32] and subsequently developed by, among others, Silva and Stefanou [31], Kapelko et al. [30] and Silva et al. [29], explicitly accounts for these adjustment costs in the production technology. This study uses this adjustment cost-based approach to dynamic inefficiency measurement.

The dynamic framework of inefficiency is built on the production technology based on the vectors of the observed quantities of N variable inputs (denoted as x), F quasi-fixed factors (denoted as K), F gross investments in quasi-fixed factors (denoted as I) and M outputs (denoted as y) for $j = 1, \ldots, J$ firms. In this dynamic production framework, the decision maker seeks to minimize variable inputs and maximize investments in quasi-fixed factors simultaneously. In this approach, the input requirement set is defined as [32]:

$$V(y : K) = \{(x, I)\} \text{ can produce } y, \text{given } K \tag{1}$$

The input requirement set is assumed to have the following properties, described in detail by Silva and Stefanou [32]: $V(y : K)$ is a closed and nonempty set, has a lower bound, is positive monotonic in variable inputs x, negative monotonic in gross investments I, is a strictly convex set, and output levels y increase with quasi-fixed inputs K and are freely disposable. Silva et al. [29] showed that the input-oriented dynamic directional distance function fully characterizes the input requirement set defined by Equation (1). The input-oriented dynamic directional distance function is defined by simultaneously contracting variable inputs x in the direction of g_x (that is the directional vector for variable inputs) and expanding gross investments I in the direction of g_I (that is, the directional vector for investments) [29,30]:

$$\begin{gathered}\vec{D}^i(y, K, x, I; g_x, g_I) = \max\{\beta \in R : (x - \beta g_x, I + \beta g_I) \in V(y : K)\}, \\ g_x \in R^N_{++}, g_I \in R^F_{++}, (g_x, g_I) \neq (0^N, 0^F)\end{gathered} \tag{2}$$

$$\text{if } (x - \beta g_x, I + \beta g_I) \in V(y : K) \text{ for some } \beta, \ \vec{D}^i(y, K, x, I; g_x, g_I) \to -\infty \text{ otherwise.}$$

Superscript i in the above formula indicates that this is an input-oriented dynamic directional distance function, while β represents the dynamic technical inefficiency as it measures the proportion in which the variable input and investment combination (x,I) is scaled. The dynamics are incorporated in Equation (2) through gross investments.

Empirical application of input-oriented dynamic directional distance function is undertaken using the nonparametric method of DEA, pioneered by Banker et al. [33] and Charnes et al. [34]. DEA is an alternative to parametric approach of efficiency analysis, offering the advantage of flexibility by not imposing a priori functional form on technology. DEA involves the application of linear programming techniques to observed inputs used and outputs produced by DMUs to obtain inefficiency measures. Based on Silva et al. [29] and Kapelko et al. [30], the input-oriented dynamic directional input distance function can be determined using DEA as follows:

$$\begin{aligned}\vec{D}^i(y, K, x, I; g_x, g_I) = \quad & \max \beta \\ & s.t. \\ & y_{m0} \leq \textstyle\sum_{j=1}^J \gamma^j y^j_m, m = 1, \ldots, M; \\ & \textstyle\sum_{j=1}^J \gamma^j x^j_n \leq x_{n0} - \beta g_{x_n}, n = 1, \ldots, N; \\ & I_{f0} + \beta g_{I_f} - \delta_f K_f \leq \textstyle\sum_{j=1}^J \gamma^j (I^j_f - \delta_f K^j_f), f = 1, \ldots, F; \\ & \textstyle\sum_{j=1}^J \gamma^j = 1; \\ & \gamma^j \geq 0, j = 1, \ldots, J.\end{aligned} \tag{3}$$

where γ^j is a vector of weights that are assigned to each firm j when constructing the dynamic frontier. The above program measures the dynamic technical inefficiency of the firms under variable returns to scale. This assumption allows for the proper modelling of firms' inefficiency in the presence of size differences and is maintained in our computations since the sample used in this study contains firms that are heterogeneous in terms of size. The values of inefficiency scores derived in Equation (3) are equal or larger than 0, where the values of 0 identify efficient firms, and the values larger than zero indicate the degree of firms' inefficiency.

In the empirical implementation of Equation (3) we use the actual quantity of variable inputs as directional vector for inputs (g_x), and 20 percent of the size of the capital stock as directional vector for investments (g_I), which is in line with previous literature (for example, [30]). The estimations of dynamic inefficiency measures are undertaken separately for each year which accommodates the potential changes in technology over time. To analyze the technological changes more precisely, one would need to adapt, for example, the Luenberger indicator that measures the change in productivity and disentangles the sources of it by looking into efficiency and technological changes. However, such analysis is out of scope of current investigations and is left for future research. We also estimate within each year for all economic sectors at the same time to be able to compare inefficiencies between them as it is well known that inefficiencies under group-specific technologies cannot be compared directly [102].

3.2. The Analysis of the Relation between CSR and Dynamic Inefficiency

To investigate the impact of dynamic inefficiency on CSR, the following model is used:

$$\text{CSR engagement} = \beta_0 + \beta_1 \text{Inefficiency} + \beta_j \sum \text{Controls}_j + \varepsilon \quad (4)$$

using panel data linear regression with fixed effects with heteroscedasticity and autocorrelation robust standard errors.

The analysis of Equation (4) may be the subject to endogeneity issues arising when a predictor variable correlates with the error term. In our case, the firm's inefficiency is endogenously determined. Endogeneity prevents the analyst from drawing causal inferences and arises from various sources such as, for example, measurement error, sample selection bias or omitted variables [103,104]. To be able to conclude correct inferences, the endogeneity issue is addressed in this study by adopting the propensity-score matching. Propensity score matching, which is a standard tool for applied researchers aiming to ascertain causal inferences, was used extensively in previous CSR research [105–107]. First introduced by Rosenbaum and Rubin [108] to study causal effects in observational studies, Li [104] applies this framework to calculate causal effects in management research. In general, propensity scoring method allows correction of the endogeneity problem related with sample selection bias [104]. In addition, the fixed effects estimation applied in the paper allows dealing with endogeneity related with omitted variable; in particular, when omitted variable is time-invariant [104,109]. Other recent techniques used in the literature to address endogeneity include the instrumental variables approach. However, our sample precludes employing this approach since it is impossible to find a variable that could serve as a valid instrument (that is uncorrelated with error term, but correlated with independent variable. In fact, some authors (for example, Love et al. [110] and Cassiman and Veugelers [111]) explained that attempts at instrumentation will not lead to improved estimation unless truly exogenous instruments can be found).

The propensity score matching methodology estimates each individual's propensity to receive a binary treatment (using probit or logit) as a function of observable variables and match individuals with similar propensities. Applying this method to calculate the causal effect involves the use of propensity scores and a matching algorithm [104]. We convert the inefficiency into binary variable to employ the probit model and assign value of 0 for efficient firms (that is, with inefficiency equal to 0), and value of 1 otherwise (that is, for inefficient firms). Using a binary variable in the main regression leads to the same results (with regard to the direction of impacts) as with application of the values of initial inefficiency scores. The following probit regression using dynamic inefficiency in a binary form as the dependent variable is run to generate a firm-specific propensity score:

$$\text{Prob}(\text{Inefficiency} = 0) = \alpha + logit\ \beta_j \sum \text{Controls}_j + \varepsilon \quad (5)$$

Upon obtaining the propensity scores, treatment firms are matched with control firms using the one-to-one matching algorithm with 0.01 caliper [112]. There are several algorithms to matching

on the propensity score. The one-to-one matching algorithm focuses on the nearest neighborhood (which uses comparison units whose propensity scores are closest to the treated unit in question) and within the caliper (which uses all comparison units that are within predefined caliper. Another widely used method is the kernel-based matching algorithm that matches all treated units with weighted average of all controls [104,113]. We use one-to-one matching algorithm which is the most common, and straight-forward to implement and interpret. Alternatively, kernel-based matching requires the definition of a bandwidth, which does not generally have an intuitive interpretation [114]. Nevertheless, for robustness check we also applied kernel-based matching and it produced similar results. This approach has an advantage of using as many comparison units as are available within the calipers [113], using matching with replacement. In general, choosing between matching without replacement and with replacement is a tradeoff between the bias and variance of estimator. In particular, matching without replacement can increase the bias of the estimator, but it can also decrease the variance of the estimator. In contrast, matching with replacement decreases the bias of the estimator at the cost of increasing the variance of estimator [113]. In addition, when there are few control units comparable to the treated units, which is the case of this study, matching with replacement is the natural choice [113].

Finally, we estimate a panel data linear regression with fixed effects allowing for heteroskedasticity and autocorrelation for the propensity-matched sample in which the dependent variable is CSR and the independent variables are the values of the first-stage probit regression. We also compare CSR values between treated and control firms. Maintaining the sign of dynamic inefficiency in this regression as the sign from Equation (4), will signify that the results are robust to endogeneity, which allows inferring causal relations.

4. Dataset and Variables

4.1. Dataset

The source of data on CSR activities of U.S. firms is Kinder, Lydenberg, and Domini (KLD) database. KLD is a comprehensive and a widely applied dataset in many research studies on CSR in a variety of areas such as management, accounting, finance, economics and marketing [44,52,54,60,64,66,115–118]. Although this dataset has its own limitations (see for example discussion by Chatterji et al. [119]), it offers a multidimensional perspective on CSR with data collected from a variety of independent sources and has the further advantage of being validated (see for example [58]). The investor relation of each firm is sent a yearly questionnaire about CSR activities. Corporate data sources include annual reports, 10K forms, proxy statements and quarterly reports as well as sustainability or environmental and community reports. The database also includes external sources such as articles about the firm in the business press (i.e., Fortune and Business Week), business magazines and media in general. Relevant articles from periodicals such as the Chronicle of Philanthropy, academic journals and also for legal issues such as the National Law Journal. Although the KLD began compiling CSR information in 1991, we restrict our analysis to the period 2004–2015, given the wider coverage of firms in the database. KLD contains detailed annual ratings on CSR activities of approximately 3000 of the largest (by market capitalization) publicly traded firms in the USA. The coverage of U.S. firms in KLD changes slightly from 2013. In particular, from 2013 firms included in KLD constitute the MSCI USA Investable Market Index (IMI), which consist of approximately 2400 firms covering approximately 99% of the market capitalization in the USA [120]. Although the firms included in KLD before and after 2013 are very similar, from 2013 there are less firms. KLD rates firms on a range of dimensions that reflect firms CSR engagement in community, diversity, employee relations, human rights, product, natural environment and corporate governance. KLD reports also the others dimensions of data concerned with firms' involvement in controversial activities (alcohol, gambling, military contracting, nuclear power, and tobacco. Research shows that firms involved in these activities resort to CSR reporting to avoid being stigmatized [69]. However, in the literature these dimensions are usually excluded from the computation of CSR scores,

because they are inherently different to other areas covered by KLD [58], they do not pertain to firms' discretionary activities [115] and there is nothing that these firms can do to change their score but exiting the industries where they operate [121]. Hence, for the same reasons we do not consider these dimensions in this study. For each CSR dimension, strengths and concerns are measured to assess the positive and negative aspects of CSR using dummy variables. When a firm presents a certain strength or concern it is assigned a value of 1, and in the opposite situation it is assigned the value of 0.

We complement the data collected from KLD with financial data from COMPUSTAT Global Vantage for 2004–2015, which presents accounting data on publicly listed firms. We merged datasets and exclude observations for which we do not have adequate data to compute dynamic inefficiency indicators as well as observations for which we do not have a complete information on control variables. We also eliminated observations with unusual characteristics such as zero or negative revenues and inputs, and also outliers following the method of Simar [122]. Overall, these procedures result in the final sample of 23,560 observations for 3840 firms (unbalanced panel). Table 1 provides details on our sample composition by each year of the sample period of 2004–2015. It shows that the first year analyzed (2004) has the largest number of observations, the period 2005–2012 is characterized by a relatively stable sample size, while from 2013 the sample size decreases (mainly due to the change in the coverage of KLD). Table 2 summarizes the sample distribution across industries by SIC codes, indicating that the majority of our sample firms represent Manufacturing industry.

Table 1. Sample description–year representation.

Year	Number of Observations	Percentage
2004	2239	9.5034%
2005	1979	8.3998%
2006	1955	8.2980%
2007	1895	8.0433%
2008	1931	8.1961%
2009	2016	8.5569%
2010	2034	8.6333%
2011	2079	8.8243%
2012	2028	8.6078%
2013	1801	7.6443%
2014	1794	7.6146%
2015	1809	7.6783%
Total	23,560	100.00%

Table 2. Sample description–industry representation.

Description	2-Digit SIC	Number of Observations	Percentage
Construction	10	328	1.3922%
Finance	37	3061	12.9924%
Manufacturing	38	10,162	43.1324%
Mining	39	1048	4.4482%
Retail Trade	48	1784	7.5722%
Services	49	4030	17.1053%
Transportation	50	2439	10.3523%
Wholesale Trade	51	708	3.0051%
Total		23,560	100.00%

4.2. Variables to Compute Dynamic Inefficiency

Estimating dynamic inefficiency using DEA requires information on firm variable inputs, quasi-fixed inputs, investments in quasi-fixed inputs and outputs. To measure these variables, we use accounting data, which is applied frequently in efficiency analysis.

Two variable inputs, one quasi-fixed input, one investment input, and one output are specified in the analysis. Variable inputs consist of the number of employees and the costs of goods sold, directly extracted from COMPUSTAT. The quasi-fixed input is measured as the firms' beginning value of fixed

assets (that is, the end value of fixed assets in the previous year), directly taken from the firms' balance sheet in COMPUSTAT. Gross investments in quasi-fixed inputs are measured as the beginning value of fixed assets in year $t + 1$ minus the beginning value of fixed assets in year t, plus the beginning value of depreciation in year $t + 1$, where firm-specific depreciation is obtained directly from profit and loss account in COMPUSTAT. Output is proxied by the firms' revenues, obtained from the firms' profit and loss accounts in COMPUSTAT. Overall, such a configuration of inputs and outputs in DEA is consistent with previous efficiency research (for example, [30,76,123]).

To construct the data to be comparable across time, these variables (except of the number of employees) are deflated using the appropriate price indices supplied by the Bureau of Labor Statistics (USA) [124]. In particular, output is deflated by the producer price index adjusted for each specific industry and subindustry. Costs of goods sold are deflated by the indices reflecting the prices of supplies to manufacturing industries and prices of supplies to nonmanufacturing industries. Fixed assets and investments are deflated using the price indices for the private capital equipment for manufacturing and private capital equipment for nonmanufacturing. By dividing the values by the price index, we create the implicit quantity indices. Table 3 shows the descriptive statistics of aforementioned variables, which indicate the considerable variation within the sample under analysis.

Table 3. Descriptive statistics of DEA variables, 2004–2015.

Variable	Mean	Std. Dev.	Coefficient of Variation
Fixed assets	1593.0723	6614.7583	4.1522
Number of employees	0.0156	0.06133	3.9195
Costs of goods sold	2422.1287	10,171.1768	4.1993
Revenues	4052.5167	14,113.2248	3.4826
Investments	332.2238	1394.8208	4.1984

Monetary values (fixed assets, costs of goods sold, revenues and investments) are in millions of US dollars, constant prices from 2003. Number of employees are in millions.

4.3. Variables to be Used in the Regression

Our dependent variable is CSR. Similar to the previous literature (for example, [42,116,117,119]), we construct a composite (net) *CSR_Score* based on KLD ratings of strengths and concerns along the following categories: community, diversity, employee relations, human rights, product, environment and corporate governance. The literature considers a wide variety of measures of CSR scores. Recent alternative possibilities are presented in Venturelli et al. [125] and Matuszak and Różańska [126]. Because the number of categories in KLD has evolved over the years, following prior research (for example [66]) we create an adjusted net measure by scaling the strength and concern scores for each firm year within each CSR category by the maximum number of items of the strength and concern scores of that category in each year, then taking the net difference between adjusted strength and concern scores for that category, and then finally summing these adjusted net differences for all categories into an overall net CSR measure. CSR is a multidimensional concept; hence, considering all dimensions and creating an aggregate index improves the construct validity [117]. However, for robustness check, we also test the CSR score derived excluding governance dimension. We elaborate on this and other robustness checks in Section 5.2.4.

Furthermore, we split *CSR_Score* into its social, environmental and governmental dimensions to test our hypotheses and assess whether there are some differences in how these dimensions are affected by inefficiency. *CSR_Soc* represents social dimension of CSR and is constructed by summing the net differences between adjusted strengths and concerns related with community, diversity, employee relations, human rights, and product. *CSR_Env* represents firms' environmental engagement and is measured as a difference between the adjusted strengths and adjusted concerns considering the single dimension of environment. *CSR_Gov* relates to corporate governance dimension and is calculated by subtracting the adjusted strengths from the adjusted concerns for the single dimension of the governance.

As a further sensitivity and robustness check, we look specifically into CSR strengths and concerns and create two additional measures: the sum of adjusted strengths *CSR_Str*, and the sum of adjusted concerns, *CSR_Con*.

Our independent variable is firm dynamic inefficiency, with values of this measure being nonnegative, as measured by the value of $\beta \geq 0$ in the optimization problem in Equation (3). Hence, the larger is the value of this indicator, the more inefficient is the firm. There is no constraint on the upper bound of this indicator. If one predicts a positive impact of efficiency on CSR, we should find a negative sign of inefficiency in the regression, and vice versa.

We include a set of variables to control for economic and institutional determinants of firm's CSR engagement (for example, [3,53,60,66,105,127,128]). *Size* is defined as the natural logarithm of total assets. For financial structure, we use two variables: *Leverage* which is the ratio of total debt to total assets, and *Cash flow* that assesses financial resources that is calculated as the ratio of cash-flow to total assets. *MTB* is the market value of equity divided by the book value of shareholder's equity. *ROA* measures profitability and is calculated as the net income divided by the total assets. *R&D* is defined as R&D expenses scaled by total revenues. For some fraction of the sample, R&D expenses are missing in COMPUSTAT. Following Lev et al. [54], for such cases we assigned 0 to this variable, since accounting rule requires firms to report such expenses. *Marketing* are marketing expenses divided by total revenues. Following Lev et al. [54], we substitute the missing values of advertising expenses by 0. Although there is no accounting rule for firms to disclose information for advertising expenses and therefore assigning 0 could understate the effect of this variable, we find similar results when removing this variable from regression. In addition, we also control for time effects through the introduction of dummies related with recent crisis as it is very likely that CSR activities of firms were impacted by this event. According to U.S. National Bureau of Economic Research [129] the recent recession in the USA began in 2007 and ended in 2009. The National Bureau of Economic Research defines recession as at least two consecutive quarters of declining GDP. Therefore, we take 2004–2006 as pre-crisis period, 2007–2009 as crisis period and 2010–2015 as post-crisis period, with post-crisis taken as reference in the regressions.

Table 4 shows the descriptive statistics for regression variables. It indicates that the mean of our main dependent variable *CSR_Score* is negative of −0.1687. Hence, on average, firms in the sample are socially irresponsible, although there is also a huge variation in the sample regarding this variable. This is further confirmed by the mean values of *CSR_Str* and *CSR_Con*, as on average, *CSR_Con* are larger than *CSR_Str* (0.4342 versus 0.2655). The mean value of social activities, *CSR_Soc* is lower than of both governance dimension, *CSR_Gov* (−0.1475 versus −0.0329), and environmental aspect of CSR, *CSR_Env* (−0.1475 versus 0.0116). The table further indicates that there are considerable dynamic inefficiencies in the sample as mean *Inefficiency* is of 0.7447. In addition, control variables of *MTB* and *R&D* present the highest variation in the values. Additional insights regarding CSR variables are provided with Figure 1 that displays the frequency distributions of these variables. Figure shows that the overwhelming majority of *CSR_Env* and *CSR_Gov* are of 0, while *CSR_Score* and *CSR_Soc* are more evenly distributed. It also indicates that *CSR_Str* is mostly concentrated around 0, while *CSR_Con* around larger numbers.

Table 4. Descriptive statistics of regression variables, 2004–2015.

Variable	Mean	Std. Dev.	Coefficient of Variation
Dependent variables			
CSR_Score	−0.1687	0.5503	−3.2620
CSR_Soc	−0.1475	0.4519	−3.0637
CSR_Env	0.0116	0.1096	9.4483
CSR_Gov	−0.0329	0.1715	−5.2128
CSR_Str	0.2655	0.4622	1.7409
CSR_Con	0.4342	0.4329	0.9970
Variable of interest			
Inefficiency	0.7447	0.2029	0.2724

Table 4. *Cont.*

Variable	Mean	Std. Dev.	Coefficient of Variation
Control variables			
Size	7.4137	1.6861	0.2274
Leverage	0.1906	0.2148	1.1268
MTB	3.1425	40.4531	12.8727
ROA	0.0247	0.1535	6.2163
R&D	2.5188	188.5142	74.8429
Marketing	0.01289	0.0709	5.5004
Cash flow	0.0624	0.1552	2.4852

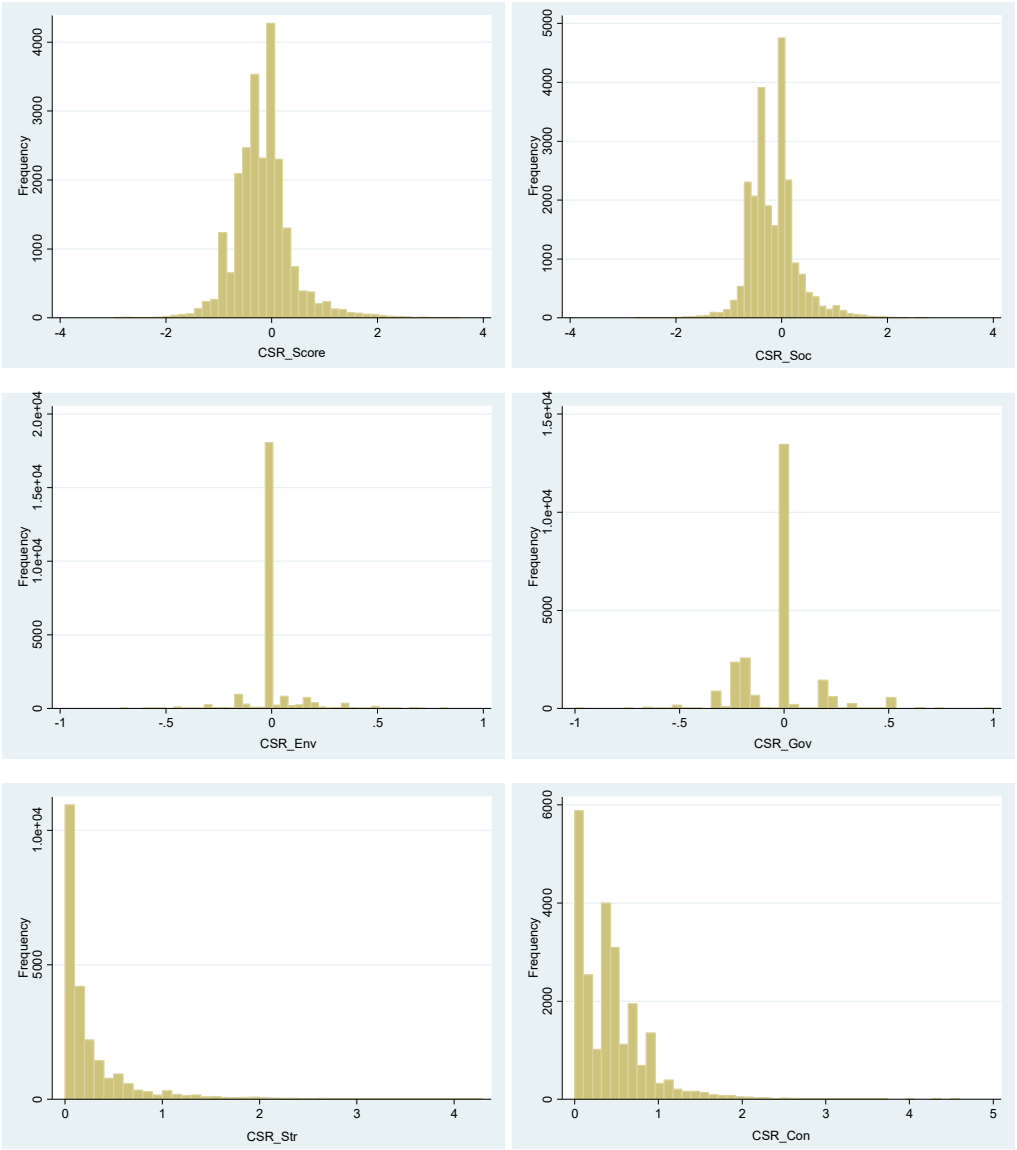

Figure 1. Frequency distribution of CSR variables.

Table 5 presents the correlation matrix for the regression variables. Inefficiency correlates negatively with *CSR_Score* and *CSR_Soc*, but positively with *CSR_Gov* (all *p*-values < 0.001); the negative correlation with *CSR_Env* is not significant. The different dimensions of CSR are correlated with each other; however, these are included separately in our models and thus, high correlations among them are not a concern. Overall, the majority of correlations between independent variables are low, hence multicollinearity should not pose a concern.

Table 5. Correlation matrix (Pearson correlation coefficients).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) CSR Score	1.0000													
(2) CSR_Soc	0.9252 (0.0000)	1.0000												
(3) CSR_Env	0.4431 (0.0000)	0.2419 (0.0000)	1.0000 (0.0000)											
(4) CSR_Gov	0.4882 (0.0000)	0.1796 (0.0000)	0.1457 (0.0000)	1.0000 (0.0000)										
(5) CSR_Str	0.6469 (0.0000)	0.5705 (0.0000)	0.4433 (0.0000)	0.2893 (0.0000)	1.0000									
(6) CSR_Con	−0.5807 (0.0000)	−0.5671 (0.0000)	−0.0900 (0.0000)	−0.3118 (0.0000)	0.2452 (0.0000)	1.0000								
(7) Inefficiency	−0.1135 (0.0000)	−0.1410 (0.0000)	−0.0099 (0.1280)	0.0138 (0.0341)	−0.2840 (0.0000)	−0.1590 (0.0000)	1.0000							
(8) Size	0.2050 (0.0000)	0.2263 (0.0000)	0.1182 (0.0000)	−0.0139 (0.0323)	0.5043 (0.0000)	0.2778 (0.0000)	−0.3592 (0.0000)	1.0000						
(9) Leverage	−0.0292 (0.0000)	−0.0189 (0.0037)	−0.0123 (0.0588)	−0.0361 (0.0000)	0.0094 (0.1507)	0.0472 (0.0000)	0.0031 (0.6333)	0.1865 (0.0000)	1.0000					
(10) MTB	0.0060 (0.3548)	0.0054 (0.4108)	0.0054 (0.4076)	0.0018 (0.7849)	0.0072 (0.2712)	−0.0001 (0.9987)	−0.0083 (0.2042)	−0.0028 (0.6684)	−0.0076 (0.2421)	1.0000				
(11) ROA	0.0478 (0.0000)	0.0473 (0.0000)	0.0352 (0.0000)	0.0060 (0.3595)	0.0830 (0.0000)	0.0279 (0.0000)	−0.0421 (0.0000)	0.1901 (0.0000)	−0.0982 (0.0000)	−0.0020 (0.7574)	1.0000			
(12) R&D	0.0013 (0.8431)	0.0043 (0.5081)	−0.0013 (0.8407)	−0.0064 (0.3272)	−0.0013 (0.8389)	−0.0031 (0.6393)	0.0123 (0.0584)	−0.0128 (0.0501)	0.0124 (0.0567)	−0.0001 (0.9925)	−0.0606 (0.0000)	1.0000		
(13) Marketing	0.0289 (0.0000)	0.0307 (0.0000)	0.0259 (0.0001)	−0.0049 (0.4538)	0.0144 (0.0267)	−0.0213 (0.0011)	−0.0184 (0.0048)	−0.0249 (0.0001)	−0.0013 (0.8416)	0.0039 (0.5482)	−0.0440 (0.0000)	−0.0015 (0.8194)	1.0000	
(14) Cash flow	0.0364 (0.0000)	0.0380 (0.0000)	0.0290 (0.0000)	−0.0019 (0.7666)	0.0797 (0.0000)	0.0388 (0.0000)	−0.0355 (0.0000)	0.1618 (0.0000)	−0.0608 (0.0000)	−0.0015 (0.8202)	0.9797 (0.0000)	−0.0609 (0.0000)	−0.0439 (0.0000)	1.0000

5. Results and Discussion

5.1. Results of Dynamic Inefficiency Indicators

Table 6 summarizes the results of dynamic inefficiency indicators per year (and pre-crisis, crisis and post-crisis periods) and by economic sector. The results indicate the large mean dynamic inefficiencies of firms in the sample (of 0.7447 for all sectors and years, on average). On average, there is a considerable scope for improvement for firms through the reduction of variable inputs and expansion of investments. Being dimensionless indicators and these indicators are computed with regard to all firms in the sample, these results can be compared across sectors. The Mining and Finance sectors are relatively less inefficient, while the Construction and Retail Trade sectors are the more inefficient ones. The finding that the Mining sector performs relatively well may be because it may be engaging more in socially responsible activities to achieve legitimacy, given it contributes considerably to environmental pollution and other harmful activities. As a result, better efficiency outcomes are realized [77]. Looking at patterns over time, all sectors present an increasing pattern of inefficiency. Comparing the specific periods related with crisis, some sectors improve their dynamic efficiency results post-crisis, while for some sectors the opposite is observed.

5.2. Results of Regression

5.2.1. Main Analysis and Hypotheses Testing: CSR and Its Components

Table 7 presents the results of our main specification for *CSR_Score*, our primary proxy of CSR engagement. Our study also investigates the influence of the components of CSR (environmental, social and governance issues) which have been identified as particularly relevant for shareholders and stakeholders at large [130]. The environmental (*CSR_Env*) and the social (*CSR_Soc*) components are the two principal components of *CSR_Score*. We also include the corporate governance (*CSR_Gov*) dimension which is also included separately as part of a broader measure of CSR [105]. The results for CSR components are also included in Table 7. The coefficient on CSR is negative and significant in *CSR_Score*, *CSR_Soc* and *CSR_Gov* and positive and significant on *CSR_Env* consistent with our predictions in Hypotheses 1 and 2. These results indicate that firms with higher dynamic inefficiency engage less in CSR. The positive sign for environmental CSR could reflect that companies facing higher operational inefficiencies value the rapid benefits provided by environmental performance which will be positively perceived by stakeholders [36]. The positive association between the environmental dimension of CSR and operational inefficiency may also be the result of the corporate orientation to this strategy which may be seen as a way of facilitating the decrease of operational costs in the future and ultimately leading to the improvement of operational efficiency [35]. The control variables are in line with prior research [105]. For example, *Size*, *Leverage*, *R&D* and *Marketing* are in general positively associated with CSR. As observed, the coefficient for the overall score of CSR is higher, generally, than the different components of CSR. The control variables reflecting before-, during- and post-crisis periods indicate that CSR performance was negatively impacted especially during the crisis period as compared to post-crisis period.

Table 6. Dynamic inefficiency results.

Period	All	Construction	Finance	Manufacturing	Mining	Retail Trade	Services	Transportation	Wholesale Trade
2004	0.7366	0.6828	0.6839	0.7648	0.4928	0.7919	0.7604	0.6924	0.7543
2005	0.7559	0.6661	0.7033	0.7898	0.5667	0.7967	0.7793	0.7067	0.7454
2006	0.7649	0.7152	0.7241	0.7901	0.6043	0.8134	0.7817	0.7337	0.7539
2007	0.7423	0.7395	0.7176	0.7674	0.5604	0.8010	0.7664	0.6874	0.7109
2008	0.7774	0.7591	0.7533	0.8103	0.6799	0.8107	0.7991	0.6850	0.7155
2009	0.7348	0.8248	0.7010	0.7593	0.5785	0.8097	0.7453	0.6490	0.7707
2010	0.7416	0.7872	0.6812	0.7706	0.6146	0.8077	0.7527	0.6878	0.7308
2011	0.7622	0.8275	0.7018	0.8014	0.5797	0.8191	0.7755	0.6963	0.7254
2012	0.5814	0.8425	0.6577	0.3835	0.6518	0.8289	0.7855	0.7082	0.7639
2013	0.7666	0.8506	0.6234	0.8050	0.6374	0.8443	0.7783	0.7227	0.7772
2014	0.7786	0.8487	0.6072	0.8238	0.6482	0.8657	0.7917	0.7351	0.7758
2015	0.8098	0.8849	0.7054	0.8310	0.6945	0.8906	0.8460	0.7716	0.8220
2004–2015	0.7447	0.7935	0.6907	0.7551	0.6069	0.8220	0.7793	0.7048	0.7540
Pre-crisis	0.7517	0.6887	0.7027	0.7807	0.5562	0.8002	0.7728	0.7108	0.7512
Crisis	0.7513	0.7761	0.7241	0.7785	0.6056	0.8070	0.7698	0.6736	0.7324
Post-crisis	0.7375	0.8414	0.6672	0.7296	0.6315	0.8415	0.7876	0.7186	0.7657

Table 7. Dynamic inefficiency and CSR.

	(1)	(2)	(3)	(4)
	CSR_Score	**CSR_Soc**	**CSR_Env**	**CSR_Gov**
Variable of interest				
Inefficiency	−0.1739 *** (0.0244)	−0.1504 *** (0.0213)	0.0079 * (0.0045)	−0.0314 *** (0.0083)
Control variables				
Size	0.0958 *** (0.0152)	0.0890 *** (0.0119)	−0.0140 *** (0.0025)	0.0208 *** (0.0047)
Leverage	0.1322 *** (0.0365)	0.0834 *** (0.0302)	0.0036 (0.0062)	0.0451 *** (0.0121)
MTB	0.0001 (0.0001)	0.0001 (0.0001)	-4.24×10^{-6} (9.21×10^{-6})	2.62×10^{-5} (3.15×10^{-5})
ROA	−0.1979 (0.3246)	−0.5346 ** (0.2485)	0.2164 *** (0.0549)	0.1204 (0.1094)
R&D	2.41×10^{-5} *** (3.12×10^{-6})	2.12×10^{-5} *** (2.22×10^{-6})	1.81×10^{-6} *** (3.59×10^{-7})	1.03×10^{-6} (1.15×10^{-6})
Marketing	0.0385 * (0.0215)	0.0293 ** (0.0131)	0.0014 (0.0044)	0.0078 (0.0069)
Cash flow	0.1332 (0.3298)	0.4744* (0.2529)	−0.2202 *** (0.0560)	−0.1210 (0.1115)
Pre-crisis period	−0.1109 *** (0.0163)	−0.0376 *** (0.0121)	−0.0593 *** (0.0036)	−0.0139 *** (0.0050)
Crisis period	−0.1229 *** (0.0138)	−0.0578 *** (0.0105)	−0.0481 *** (0.0029)	−0.0170 *** (0.0041)
Constant	−0.7197 *** (0.1174)	−0.7041 *** (0.0921)	0.1446 *** (0.0204)	−0.1602 *** (0.0362)
Fixed effects	Yes	Yes	Yes	Yes
Observations	23,560	23,560	23,560	23,560
R^2	0.0542	0.0745	0.0753	0.0099

Standard errors are robust and are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

5.2.2. Additional Analysis: CSR by Strengths and Concerns

Prior work argues that strengths and concerns are not opposing effects but distinct types of social actions that may show different effects [131]. Following this research, we disaggregate strengths (i.e., responsible CSR) and concerns (i.e., irresponsible CSR) [42] by decomposing our main dependent variable, *CSR_Score*, into total strengths, *CSR_Str*, and total concerns, *CSR_Con*. Table 8 presents the results. These findings show that dynamically inefficient firms have more concerns than dynamically efficient ones. The coefficient for CSR strengths is negative and significant reflecting that more dynamically efficient firms tend to have more strengths. Results related to the control variables are also in line with prior research [105]. For example, the coefficients for *Size* and *R&D* are positive for *CSR_Str* but negative for *CSR_Con*. Moreover, *Leverage* is negatively associated with *CSR_Con*. Dummies related with time periods indicate that crisis, in comparison with the post-crisis period, negatively influenced firms CSR strengths, while the impact on CSR concerns was positive.

Table 8. Dynamic inefficiency and CSR by strengths and concerns.

	(1)	(2)
	CSR_Str	**CSR_Con**
Variable of interest		
Inefficiency	−0.1016 *** (0.0192)	0.0723 *** (0.0167)
Control variables		
Size	0.0279 *** (0.0098)	−0.0679 *** (0.0106)
Leverage	0.0185 (0.0223)	−0.1137 *** (0.0278)
MTB	1.32×10^{-5} (4.51×10^{-5})	−0.0001 (0.0001)
ROA	−0.1618 (0.1929)	0.0361 (0.2308)
R&D	1.64×10^{-5} *** (1.49×10^{-6})	-7.67×10^{-6} *** (2.27×10^{-6})
Marketing	−0.0083 (0.0077)	−0.0468 ** (0.0199)
Cash flow	0.0964 (0.1963)	−0.0368 (0.2360)
Pre-crisis period	−0.1250 *** (0.0107)	−0.0141 (0.0101)
Crisis period	−0.0865 *** (0.0085)	0.0364 *** (0.0090)
Constant	0.1826 ** (0.0774)	0.9024 *** (0.0804)
Fixed effects	Yes	Yes
Observations	23,560	23,560
R^2	0.1973	0.0722

Standard errors are robust and are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

5.2.3. Endogeneity of Dynamic Inefficiency

Endogeneity concerns emerge as a firm's operational inefficiency is arguably endogenously determined as the factors driving operational inefficiency might also influence CSR engagement decisions. Besides accounting for endogeneity related with time-invariant omitted variable through application of fixed effects model, the propensity-score matching method is well suited to address endogeneity concerns.

The results for the regression for *CSR_Score* are reported in Table 9, Columns 1 and 2. First, we obtain the propensity score for each firm and run the probit model in Equation (5) using the same independent variables as in our prior models. Results of the probit model are tabulated in Table 9, Column 1. These results indicate that *Size*, *MTB*, and *Cash flow* are negatively related to the probability of a firm being dynamically efficient, while *Leverage*, *ROA* and *Marketing* are positively associated. In the next step, we match treatment firms with control firms following a one-to-one match with a replacement process and a 0.01 caliper with these results presented in Table 9, Column 2. The mean *CSR_Score* for operationally inefficient firms is lower than the mean *CSR_Score* for those of the control firms (−0.1734 vs. −0.0169, respectively and significant at 1%). Consistent with our main

analysis in Table 7, we find that the coefficient on dynamic inefficiency remains negatively associated with *CSR_Score*. In addition, the coefficients on control variables remain related with CSR in the same direction as in our main analysis in Table 7 (although the relations do not always maintain the same significance).

An interesting observation is that the coefficient on the dynamic inefficiency score in Table 9 is of greater magnitude than the one in Table 7. This can be explained by the fact that in our main analysis we use the inefficiency score with its full range of values (i.e., greater than or equal to 0). However, the propensity score matching and probit models require converting our inefficiency score to the binary form. While these two variables both measure dynamic inefficiency, they are expected to have a slightly different impact on CSR. Similarly, the coefficients of the control variables have different magnitude of impact on CSR (and sometimes also the significance) comparing our main results with results of propensity score matching.

Further, we produce the propensity score matching for social, environmental and governance dimensions of CSR and the results, reported in Table 9 (Columns 3–5), are in line with the results presented in Table 7. After undertaking the propensity score procedure, the coefficients on inefficiency remain negatively associated with *CSR_Soc* and *CSR_Gov* scores, and positively with *CSR_Env* score.

Similarly, we conduct the analysis for CSR strengths and concerns. Table 9, Column 6 presents the results of the propensity score matching on the CSR strengths. As in our main results reported in Table 8, we find a negative association between dynamic inefficiency and *CSR_Str*. Table 9, Column 7 summarizes the propensity score matching for CSR concerns, showing a positive association between *CSR_Con* and firms being inefficient in operational performance, indicating that inefficient firms engage in more CSR activities considered the "bad side" of CSR. Hence, this is consistent with our main results pertaining to CSR concerns in Table 8. Of course, the results of the first stage of propensity scoring, that is running the probit model given by Equation (5), are the same regardless the dimension of CSR considered. Therefore, we report them only once in Table 9, Column 1.

We also undertake the same analysis using logit instead of probit as well we apply different definition of the inefficiency dummy created in the function of the inefficiency score being below the average (assigning 0 in this case) and above the average of the sample (assigning 1 in this case). The results and conclusions obtained in Table 9 replicate in this additional analysis.

5.2.4. Robustness Tests

This section contains the summary of several additional tests conducted to determine the robustness of the findings.

First, we examine the robustness of the findings analyzing further definitions of CSR. In particular, prior research often perceives corporate governance as a distinct construct from CSR (for example, [42, 52]). Therefore, the governance dimensions of *CSR_Score*, *CSR_Str* and *CSR_Con* are excluded. Our main findings continue to persist, also these related to the propensity score matching.

Further, we also test other definitions of our main dependent variable of dynamic inefficiency. In particular, we check whether our results persist when: (1) computing dynamic inefficiency scores using the actual values of both variable inputs and investments as directional vectors because the choice of directional vector might influence the results; and (2) creating a dummy variable based on our inefficiency results assigning a value of 0 for efficient firms (defined as both firms with inefficiency score equal to 0 and firms with inefficiency score below the average value), and value of 1 otherwise. The results obtained are in line with these reported in our main analysis.

Table 9. Propensity score matching—CSR score, CSR social, environmental and governance dimensions and CSR strengths and concerns.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	First-Stage Dynamic Inefficiency	**Matched-Sample CSR_Score**	**Matched-Sample CSR_Soc**	**Matched-Sample CSR_Env**	**Matched-Sample CSR_Gov**	**Matched-Sample CSR_Str**	**Matched-Sample CSR_Con**
Variable of interest							
Inefficiency		−0.2341 ***	−0.1971 ***	0.0206 ***	−0.0575 ***	−0.0339 ***	0.2002 ***
		(0.0118)	(0.0097)	(0.0023)	(0.0038)	(0.0088)	(0.0076)
Control variables							
Size	−0.1199 ***	0.0912 ***	0.0756 ***	−0.0137 ***	0.0293 ***	0.0482 ***	−0.0430 ***
	(0.0094)	(0.0083)	(0.0067)	(0.0015)	(0.0028)	(0.0056)	(0.0058)
Leverage	0.1824 **	0.1731 ***	0.0818 ***	0.0325 ***	0.0588 ***	0.0693 ***	−0.1039 ***
	(0.0884)	(0.0258)	(0.0204)	(0.0043)	(0.0091)	(0.0163)	(0.0181)
MTB	−0.0008 **	-4.7×10^{-5}	-4.46×10^{-5}	-5.53×10^{-6}	3.14×10^{-6}	−0.0001	-1.27×10^{-5}
	(0.0004)	(0.0001)	(0.0001)	(1.09×10^{-5})	(2.2×10^{-5})	(4.53×10^{-5})	(4.53×10^{-5})
ROA	1.7503 ***	−0.8402 ***	−0.5108 ***	0.3026 ***	−0.6320 ***	−0.6245 ***	0.2156 *
	(0.5331)	(0.1900)	(0.1429)	(0.0342)	(0.0804)	(0.1172)	(0.1266)
R&D	2.3×10^{-5}	2.8×10^{-5} ***	2.18×10^{-5} ***	3.24×10^{-6}**	2.50×10^{-6}	2.03×10^{-5}***	-7.26×10^{-6}
	(0.0002)	(9.92×10^{-6})	(7.01×10^{-6})	(1.34×10^{-6})	(3.30×10^{-6})	(4.90×10^{-6})	(5.69×10^{-6})
Marketing	1.1013 *	0.0394	0.0281	0.0024	0.0090	−0.0120 *	−0.0514 **
	(0.6482)	(0.0261)	(0.0182)	(0.0038)	(0.0068)	(0.0064)	(0.0240)
Cash flow	−1.5446 ***	0.8210 ***	0.4848 ***	−0.3154 ***	0.6516 ***	0.5622 ***	−0.2587 **
	(0.5203)	(0.1931)	(0.1452)	(0.0349)	(0.0821)	(0.1193)	(0.1288)
Pre-crisis period	0.4430 ***	−0.1374 ***	−0.0536 ***	−0.0598 ***	−0.0240 ***	−0.1455 ***	−0.0082
	(0.0466)	(0.0100)	(0.0079)	(0.0021)	(0.0035)	(0.0073)	(0.0072)
Crisis period	0.4933 ***	−0.1423 ***	−0.0759 ***	−0.0508 ***	−0.0156 ***	−0.1111 ***	0.0312 ***
	(0.0486)	(0.0081)	(0.0064)	(0.0016)	(0.0027)	(0.0057)	(0.0056)
Constant	2.6398 ***	−0.7156 ***	−0.5888 ***	0.1203 ***	−0.2471 ***	−0.0386	0.6769 ***
	(0.0808)	(0.0626)	(0.0508)	(0.0114)	(0.0215)	(0.0425)	(0.0447)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,560	23,558	23,558	23,558	23,558	23,558	23,558
R^2	0.0574	0.6651	0.6671	0.6711	0.4880	0.7708	0.7656
Treated sample: CSR_Soc/CSR_ Env/CSR_Gov mean		−0.1734	−0.1512	0.0117	−0.0338	0.2568	0.4301
Observations		22,858	22,858	22,858	22,858	22,858	22,858
Control sample: CSR_Soc/CSR_ Env/CSR_Gov mean		−0.0169	−0.0242	0.0090	−0.0016	0.5512	0.5681
Observations		699	699	699	699	699	699
Mean difference—*t* test		−0.1565 ***	−0.1270 ***	0.0027*	−0.0322 **	−0.2945 ***	−0.1380 ***

Standard errors are robust and are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

The last set of robustness tests is related to control variables. As explained before, in our analysis we use fixed effects model (controlling by time through crisis-related dummies) that eliminates all time-invariant variables such as economic sector, hence we cannot use sector dummies in the regressions given that, in principle, firms do not switch to other sectors over time. However, researchers tried to account for sector effects in fixed effects regressions through two methods [3,105]. The first method controls for the average value for the corresponding sector (by detracting it from the dependent variable). The second approach includes an additional variable equal to the average of the dependent variable over the sectors (excluding firm in question). We explored both solutions and our findings on the relation between CSR (the general score, the different dimensions and the positive and negative aspects of strengths and concerns), and dynamic inefficiency and control variables remain the same as in our main analysis. In addition, the results of propensity score matching persist. Finally, we also verify whether the results are robust to different definition of our control variable related with time and crisis. Although the U.S. economic recession ended in 2009, the recovery after this year was still weak. Therefore, we verify whether the extension of the crisis dummy to include 2010 and 2011, changes our results. This analysis shows that our findings persist with the change in the definition of the crisis period.

6. Conclusions

With an extensive literature on CSR engagement focusing on whether this investment increases shareholder value, we address the more fundamental relationship between CSR and corporate performance operational inefficiency. Upon measuring operational inefficiency in a dynamic framework using DEA method, we explore its relationship with the CSR engagement strategy. Specifically, we find that more operationally inefficient firms have less CSR commitment. The effect is mainly driven by social activities and has an opposite sign for corporate engagement in CSR environmental activities, and is in line with more inefficient firms also showing more CSR concerns and less CSR strengths. This evidence is in line with more inefficient companies investing in CSR activities addressed to external stakeholders which result in a more immediate and visible effect. Even though this strategy is not as sustainable as the internal-oriented CSR activities, it may be the most attractive strategy for companies facing higher inefficiency. In addition, we find considerable dynamic inefficiencies of firms in the sample, with the Mining and Finance industries presenting, on average, the lowest values of inefficiency and Retail Trade and Construction sectors presenting the largest.

The measure of performance is based on the firm gains arising from the marketed activities. The implicit value of the CSR activities is on the firm's intangible assets that can create wealth for shareholders. Clearly, a firm's CSR program can add value to the brand equity [63]. This is an output-orientation to measuring value. On the input side, core inputs can be impacted by a firm's CSR performance. This reflects on investors willing to invest in firms engaging in serious CSR programs, as well as being attractive to good employees wanting to work for such firms. Arguably, and in line with RBV, one characterization of firm competitiveness is that a competitive firm can attract the resources it needs when it needs them. Being engaged in a CSR program can impact capital access and labor quality.

Our research answers a call for the need to broaden the understanding of the term CSP to encompass the nature of activities of a firm related to its main stakeholders [11]. Specifically, we extend prior research on the association between CSR and operational inefficiency which has focused on the analysis of one specific sector. Typically, single-dimension, narrow measures (e.g., philanthropic contributions or pollution controls mechanisms) have been used to assess corporate social performance in relation to operational inefficiency. More importantly, we broaden this discussion by using the dynamic measure of firms' inefficiency that accounts for the intertemporal linkages of firms' production decisions through adjustment costs associated with changes in quasi-fixed factors induced by investments. This provides an unbiased assessment of firms' inefficiency.

Our work is relevant for academics, policy makers and investors. We show that managers consider the operational inefficiency of the firm when choosing their CSR engagement strategy which provides existing investors and potential ones with further insights on the firm CSR preferences and the importance allocated to this important investment decision. Future research efforts could analyze whether higher firms' dynamic productivity growth leads to the participation in CSR activities by applying dynamic Luenberger indicator [132]

This analysis could disentangle the contributions of dynamic inefficiency change and dynamic technological change and their effects on CSR. Furthermore, future research could be devoted to undertake the separate analysis of CSR and dynamic efficiencies of firms involved in controversial activities. Looking into specific sectors more deeply and their relationships between dynamic inefficiency and CSR could be an obvious extension of the present study. In addition, further robustness of findings could be obtained by the application of bootstrap methods in the estimation of dynamic efficiency measures. Nevertheless, this would require a previous analysis of the properties (consistency, rate of convergence, asymptotic distributions, etc.) of the efficiency estimator, which has not been studied so far in a dynamic efficiency context. Hence, we leave it is as an open research question to be analyzed in future research.

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