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Do Environmental, Social and Governance Activities Improve Corporate Financial Performance?

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Abstract

This study investigated the relationship between corporate efficiency and corporate sustainability to determine whether firms concerned about environmental, social and governance (ESG) issues can also be efficient and profitable. We applied data envelopment analysis to estimate corporate efficiency and investigated the nonlinear relationship between corporate efficiency and ESG disclosure. Evidence shows that corporate transparency regarding ESG information has a positive association with corporate efficiency at the moderate disclosure level, rather than at the high or low disclosure level. Governance information disclosure has the strongest positive linkage with corporate efficiency, followed by social and environmental information disclosure. Moreover, we explored the relationship between particular ESG activities and corporate financial performance (CFP), including corporate efficiency, return on assets and market value. We found that most of the ESG activities reveal a non-negative relationship with CFP. These findings may provide evidence about voluntary corporate social responsibility (CSR) strategy choices for enhancing corporate sustainability.

Keywords: Corporate Efficiency, Data Envelopment Analysis, ESG Disclosure, ESG Activities, Corporate Social Responsibility, Stakeholder Engagement, Sustainable Development

1. Introduction

In the past several decades, a profound trend has begun to emerge in corporate sustainability, from voluntary engagement in sustainable activities to de facto requirements due to both social expectations and regulatory pressure (Brockett and Rezaee, 2012). The number of firms that employ sustainability strategies and disclose environmental, social and governance (ESG) information continues to increase, which has caused fundamental changes to occur in business models and management theory. Conventional shareholder-oriented management (Friedman, 1970) aims to enhance financial performance and maximize the benefits of shareholders. In contrast, sustainable business promotes stakeholder-oriented management (Freeman and McVea, 2001), which takes all the stakeholders, including shareholders, consumers, customers, communities and other related groups, into consideration and focuses on reducing externalities and maximizing social value regarding ESG issues.

To date, a large amount of empirical literature has examined the relationship between corporate financial performance (CFP) and corporate sustainability to identify the implications of stakeholder-oriented management for CFP (Brower and Rowe, 2017; Deng et al., 2013; Garcia et al., 2017; John, 1992; Margolis et al., 2009; Orlitzky et al., 2003; Wang and Sarkis, 2017). Regarding this relationship, two views prevail in the literature. On the one hand, according to the Porter hypotheses (Ambec et al., 2013; Porter and Linde, 1995), corporate social responsibility (CSR) activities, especially environmental activities, are a source of innovation that creates extra revenue that can cover the additional costs, so an appropriate CSR strategy can be positively related to CFP. The majority of empirical studies show a positive linkage between CFP and CSR (Deng et al., 2013; John, 1992; Margolis et al., 2009; Orlitzky et al., 2003). On the other hand, CSR activities bring additional costs caused by agency problems and inefficient resource allocation, which will put the firm at an unfavorable position in the free and competitive market (Friedman, 1970; Sternberg, 1997). A summary of empirical studies found that negative relationships also exist between corporate social performance and financial performance (Margolis and Walsh, 2003). In addition to positive and negative relationships, a neutral relationship has also been found between CFP and CSR (McWilliams and Siegel, 2001; Moore, 2001).

The uncertainty in the findings leaves unresolved questions. The reasons for the failure to reach a consensus regarding the implications of CSR for CFP are related to several aspects. First, the wide range of CFP metrics makes it difficult to determine a general relationship regarding this issue. Market-based metrics are the most frequently applied approaches (Peloza, 2009), which include share price, mutual fund returns, and market value (Fatemi et al., 2016). Corporate financial performance is widely assessed by accounting-based metrics, such as return on assets (ROA) and return on equity (ROE) (Ferrell et al., 2016; Lee et al., 2016). Choosing the appropriate mechanism to meaningfully support corporate decision-making and policy analysis can be problematic. The frequently used single metric fails to capture potential CSR implications.

Second, a variety of CSR concepts and categories complicate drawing conclusions about the CSR-

CFP relationship. CSR is a multidimensional construct (Waddock and Graves, 1997). Firms have different motivations for practicing CSR strategies and use a wide range of resources, which lead to different CFP implications. Studies that focus on different types of CSR activities may reach different conclusions about the CSR-CFP relationship.

Third, as Barnett and Salomon (2006) have noted, the relationship between CFP and CSR is neither strictly positive nor strictly negative. There may have been problems with the previous studies on this issue that simply concluded a linear relationship between CFP and CSR. Studies that have found an inverted U-shaped relationship between CFP and corporate environmental performance also provide evidence for the nonlinear relationship (Fujii et al., 2013; Trumpp and Guenther, 2017).

In this study, we classified CSR strategy into two categories, ESG information disclosures and ESG activities, such as green building policy, equal opportunity policy and independent directors. We used a relatively large sample that covers major countries worldwide and 11 sectors from the Bloomberg ESG database. We attempt to determine how ESG information transparency is related to corporate efficiency, whether the disclosure level has different effects on corporate efficiency, and which types of activities would have a positive effect on CFP.

We have contributed to the existing literature in three aspects. First, we used corporate efficiency as an indicator of CFP to avoid the problem of a single metric. Data envelopment analysis (DEA) allows us to estimate corporate efficiency by considering all the productive factors. Not only revenue and assets, which are the frequently used CFP metrics, but also labor and the cost of goods sold are included in the DEA model. This comprehensive evaluation of CFP includes more possible CSR implications than a single metric.

Second, the nonlinear relationship between corporate efficiency and ESG disclosure was investigated by nonparametric regression and piecewise linear regression analysis. We found that a moderate disclosure level is positively related to corporate efficiency, rather than a high or low disclosure level.

Third, we applied the same pattern of analysis to the components of environmental, social and governance issues. We compared the three main aspects of corporate sustainability in terms of the differences in both information disclosure and activities and found that governance disclosure has the strongest positive effect on corporate efficiency. We tested the effect of 26 ESG activities, including 11 environmental activities, 6 social activities and 9 governance activities, on corporate efficiency. Moreover, a comparison with ROA and market value was used to test the consistency of the corporate efficiency indicator.

Figure 1 shows the research framework of this study. The research design involves two steps. In the first step, we estimated corporate efficiency by using the DEA model, with revenue as output and fixed assets, numbers of employees and cost of goods sold (COGS) as inputs. In the second step, we attempted to clarify the CSR-CFP relationship. First, the nonlinear relationship between corporate efficiency and ESG disclosure was investigated. Then, we explored which types of activities would have a positive effect on corporate efficiency, ROA and market value.

[Insert Figure 1 about here]

The paper proceeds as follows. Section 2 summarizes the relevant literature on the relationship of CFP with ESG disclosures and activities. Based on the previous studies, we propose several hypotheses about ESG. Section 3 explains the methodology, including the DEA model and nonparametric and parametric regression models. Section 4 describes the sample and the variables used in this study. Section 5 presents the empirical results and discussion. Finally, we conclude in section 6.

2. Literature review and hypotheses

2.1 Corporate financial performance and ESG disclosure

Several theories explain the reasons why firms voluntarily disclose ESG information. First, the legitimacy theory perspective argues that ESG disclosure is aimed at gaining social legitimacy for environmental or social impacts caused by the firm's operation. A firm's ESG legitimacy is a strong motive for ESG disclosure (Lokuwaduge and Heenetigala, 2017). Furthermore, under the pressure of social media and the attention of stakeholders, ESG disclosure is a tool for impression management that can maintain and enhance corporate reputation (Brammer and Pavelin, 2008; Higginson et al., 2006; Patten, 1992). Second, information asymmetry between firm managers and outside investors is another motivation for voluntary corporate disclosure (Shane et al., 1983). The lemon problem arises from information asymmetry between managers and outside investors. Investors will undervalue good performing companies and overvalue bad performing companies based on the limited information. Thus, the capital market will fail to optimally allocate resources. One solution for the lemon problem is to send reliable signals to the market to diminish the information asymmetry between managers and outside investors. Socially responsible investment (SRI) has increased dramatically worldwide in the past decades. Investors with intrinsic social preferences are more likely to hold socially responsible funds, rather than conventional funds of higher financial performance (Riedl and Smeets, 2017). Thus, corporations have become more prone to disclosing ESG information. Third, corporate information disclosure is a discretionary-based disclosure, which reflects managerial discretion regarding how much information managers choose to disclose (Verrecchia, 1990, 2001). There is a tradeoff faced by managers regarding to what extent they should disclose corporate information, favorable or unfavorable, to value the firm in a rational market. Firms (the seller) prefer to disclose favorable information and withhold unfavorable information to enhance their evaluation in the market. On the other hand, outside investors (the buyer) discount the firm's value by considering the undisclosed information as unfavorable information. This compels firms to reveal more information even though it may be unfavorable.

As the theories above explain, ESG disclosure may bring firms a competitive advantage in a rational market. However, previous empirical studies have found a mixed relationship between CFP and ESG disclosure. Aerts et al. (2008) found that more environmental disclosure could be translated to precise

earnings forecasts by analysts, which implies that improved environmental disclosure is positively related to CFP. Clarkson et al. (2011) found that environmental disclosure improved CFP in polluting industries in the United States. In addition to environmental disclosure, governance disclosure also benefits the principal. Larger firms that introduce more stringent disclosure regimes will employ more capable managers, which leads to better financial performance (Hermalin and Weisbach, 2012). Corporations that publish an ESG report have a higher stock market return (Weber, 2014). Higher ESG transparency boosts firm value (Yu et al., 2018), and integrated ESG reporting leads to a higher market valuation than stand-alone reporting (Mervelskemper and Streit, 2017). Conversely, Qiu et al. (2016) did not find any relation between environmental disclosure and CFP but found that social disclosure was positively related to CFP. However, negative relationships have also been found between information disclosure and CFP (Lorraine et al., 2004; Santos and Escanciano, 2002).

Against this backdrop, even though mixed relationships exist, it is important to note that previous studies have seldom investigated the nonlinear relationship between corporate efficiency and ESG disclosure. They also failed to consider the three types of disclosures together to compare the differences among them. One exception is the study by Nollet et al. (2016). They argued that ESG disclosure possessed a quadratic relationship with CFP and found a U-shaped relationship between governance disclosure and CFP. Consistent with this finding, we further investigate how corporate efficiency is related to ESG disclosure and distinguish the relationships at different disclosure levels. As such, we hypothesize the following.

Hypothesis 1a. Corporate efficiency presents a nonlinear relationship with overall ESG disclosure, and a positive relationship exists at a certain disclosure level.

Hypothesis 1b. Corporate efficiency has a nonlinear relationship with the environmental, social and governance components of disclosures. Among the three components of ESG disclosure, governance disclosure has the strongest effect on corporate efficiency.

2.2 Corporate financial performance and ESG activities

ESG activities include both managerial discretion and compulsory obligations. The relationship between CFP and CSR strategy choices has been extensively discussed in previous studies. In terms of environmental activities, the traditional view argues that environmental regulations are an additional cost to the company that reduce profitability and lead to low efficiency. Conversely, the Porter hypothesis argues that stringent, but flexible, environmental regulation may stimulate companies to innovate technologically or managerially. These innovations create efficiencies that offset the additional costs and, in the future, generate more revenue. However, whether environmental regulations can stimulate additional revenue that exceeds the additional cost and lead to higher corporate efficiency remains to be determined (Ambec et al., 2013). Another concern is that firms may also symbolically conform to environmental policies without actual efforts to pursue the environmental goals (Haque and Ntim, 2018). Empirically, adopting stringent global environmental standards will

lead to much higher market value compared to less stringent regulations (Dowell et al., 2000). In a high growth industry, positive links between environmental performance and profitability will be strengthened (Michael and Paul, 1997). According to the previous studies discussed above, we propose that only policies that cut costs or bring extra revenue will be positively related to corporate efficiency.

Hypothesis 2. Environmental activities that are cost cutting are positively related to corporate efficiency.

In terms of social activities, good corporate social performance, such as corporate charitable giving, will have a positive effect on financial performance in the long run (Brammer and Millington, 2008). Moreover, these long-term benefits could be stronger in the sectors that depend more on reputation, brands and large quantities of natural resources (Eccles et al., 2014). However, social activities bring the same concerns regarding additional costs as environmental activities. Thus, we propose hypothesis 3.

Hypothesis 3. Social activities that enhance corporate reputation and attract capable employees with little additional cost are positively related to corporate efficiency.

In terms of governance activities, many studies explored the relationship between board structure and CFP. Positive relationships were found for several aspects. In the case of independent directors, Luan and Tang (2007) found that having an independent director has a significantly positive impact on a firm's performance. Zhu et al. (2016) found that, in China, empowering independent directors is positively associated with firm value. Regarding the issue of women on the board, many studies found that board gender diversity may improve CFP (Erhardt et al., 2003; Hoobler et al., 2016; Terjesen et al., 2016; Wang, 2012). In certain industries, such as the banking industry, good corporate governance also has a positive effect on CFP (Esteban-Sanchez et al., 2017). Following the previous studies, we further added global sustainable governance principles as a factor in our analytical model to investigate how governance activities are linked with corporate efficiency. We propose the following hypothesis.

Hypothesis 4. Governance activities that involve an independent and diversified board of directors are positively related to corporate efficiency.

3. Methodology

3.1 Estimation of Corporate Efficiency

To estimate corporate efficiency, we applied DEA, a multivariable estimation method widely used to evaluate the efficiency of companies and utilities. We applied the input oriented model (Banker et al., 1984) by minimizing inputs and maintaining the output at its current level, as shown in **equation (1)**, where x_i denotes inputs, including COGS, net fixed assets and number of employees, and y_r

denotes the output, the revenue.

$$\begin{aligned}
\theta^* &= \min \theta \quad \text{subject to} \\
\sum_{j=1}^n \lambda_j x_{ij} &\leq \theta x_{i0}, i = 1, 2, \dots, m; \\
\sum_{j=1}^n \lambda_j y_{rj} &\geq y_{r0}, r = 1, 2, \dots, s; \\
\sum_{j=1}^n \lambda_j &= 1 \\
\lambda_j &\geq 0, \quad j = 1, 2, \dots, n;
\end{aligned} \tag{1}$$

In **equation (1)**, $\sum_{j=1}^n \lambda_j = 1$ indicates the variable returns to scale feature. θ^* is the input oriented efficiency of each decision-making unit and ranges from 0 to 1. If $\theta^* = 1$, then the input cannot be reduced, which implies that the company's performance is at the optimal level. If $\theta^* < 1$, then the input should be reduced by θ^* to become efficient, which indicates that the firm is less efficient than its peers.

3.2 Regression Model

Based on the corporate efficiency score estimated by the DEA model above, we specified three regression models to investigate the relationship between corporate efficiency and corporate sustainability strategies.

First, we used nonparametric regression to investigate the relationship between corporate efficiency and the ESG disclosure score. In the regression model, Eff_i is the corporate efficiency and x_i is disclosure score, which includes the overall ESG disclosure score and the components E, S, and G of the disclosure score, as shown in **equation (2)**. The Epanechnikov kernel estimator was used to smooth the regression result.

$$Eff_i = m(x_i) + \varepsilon_i, i = 1, \dots, N \tag{2}$$

Second, to validate the nonparametric regression result and examine to what degree the ESG disclosure scores are related to corporate efficiency, we further divided the ESG disclosure score into quarters (low, lower-middle, upper-middle and high disclosure levels) to test the slope of each interval by using piecewise linear regression. X_i represents the firm characteristics.

$$Eff_i = \beta_0 + \beta_i Disclosure_i + \alpha_i X_i + \mu_i \tag{3}$$

Third, ordinary least square regression was applied to investigate the relationship of corporate efficiency with environmental, social and governance activities. The coefficients β_i explain how corporate efficiency is related to ESG activities.

$$Eff_i = \beta_0 + \beta_i ESG_i + \alpha_i X_i + \mu_i \tag{4}$$

$$ROA_i = \beta_0 + \beta_i ESG_i + \alpha_i X_i + \mu_i \tag{5}$$

$$Tobin's\ Q_i = \beta_0 + \beta_i ESG_i + \alpha_i X_i + \mu_i \tag{6}$$

We mainly investigated how corporate efficiency is related to ESG activities. Furthermore, we also specified models by using ROA and market value as dependent variables. ROA is calculated from

earnings before interest and taxes (EBIT), interest expenditure, tax expenditure and total assets. We used Tobin's Q (total market value divided by total assets) as the indicator of market value and took the natural logarithm value to eliminate the effect of outliers (Aouadi and Marsat, 2016; Jo and Harjoto, 2011). X_i represents the control variables. We added sector and country dummy variables to control for both sector and country features. Liang and Renneboog (2017) have noted that CSR practices vary significantly across countries, according to different legal origins that play an important role in driving financial and economic outcomes. We also controlled for R&D expenditures, firm size and financial risk. Larger firms may take advantage of economies of scale to enhance revenue and market value. We used the value of the natural logarithm of the number of employees as the indicator of firm size. Firms are vulnerable to financial burden. Firms with high financial leverage are more likely to lose market share and experience a negative effect on profitability and market value (Opler and Titman, 2009). To control for financial risk, we used the natural logarithm value of financial leverage (total liability divided by equity) to indicate financial risk.

4. Data

We used the Bloomberg Environmental, Social and Governance Database, which offers both the financial data and ESG information of global companies. Bloomberg Professional Service provides the ESG information collected from firms' annual reports, sustainability reports, press releases and third-party research and covers information on board structure, such as the percentage of women on the board and independent directors. The transparency of ESG information is indicated by the index called the ESG disclosure score, in which every data point is weighted in terms of importance and tailored to different industry sectors. The Bloomberg ESG disclosure score ranges from 0.1, which indicates the lowest disclosure level, to 100, for firms that disclose every data point collected by Bloomberg (Siew, 2015).

We gathered financial data and ESG information, including the overall ESG disclosure score, components of environmental, social and governance disclosure scores and ESG activity-related data of global companies. This study consisted of two steps: The first step involved estimating the corporate efficiency for each firm by using financial data. The second step involved analyzing the relationship between corporate efficiency and ESG disclosure as well as ESG activities.

In the first step, the financial data of 6631 companies in 2015 from 74 countries¹ and 11 sectors were used to estimate the corporate efficiency for each firm. We used revenue as the output. In terms of inputs, COGS, net fixed assets and number of employees were used as inputs to estimate corporate efficiency. Given the features of the different sectors, corporate efficiency was calculated by sector. **Table 1** shows the descriptive statistics for all the observations. The descriptive statistics for each sector are shown in **Appendix Table S1**.

¹ Most observations come from the top three economies, the United States (2030 obs.), China (1042 obs.) and Japan (1908 obs.). Among the remaining observations, European countries account for a large proportion.

[Insert Table 1 about here]

In the second step of the regression analysis, we used the ESG disclosure score, components of environmental, social and governance disclosure scores and ESG activity-related data to analyze their relationship with corporate efficiency. As shown in Table 1, the average governance disclosure score (G score) is higher than both the environmental disclosure score (E score) and the social disclosure score (S score). ESG-related activities consisted of ESG policies and initiatives. We gathered 26 ESG activities, including 11 environmental activities, 6 social activities and 9 governance activities. The variables illustrating whether the firm implemented the related policies or initiatives are all dummy variables, for which 0 indicates that the firm does not practice the activity and 1 indicates that the firm does perform the activity. For governance activities, we also collected information regarding the percentage of women on the board, independent directors, CEO duality and audit committee meetings. The descriptions for all ESG activities are listed in **Table 2**. Based on the sample for corporate efficiency estimation, we selected observations by dropping the missing values for each regression model. The sample size varies as the model changes. For detailed descriptive statistics for all ESG activity variables, see **Appendix Table S2, S3 and S4**.

[Insert Table 2 about here]

5. Results and discussions

5.1 Corporate efficiency

Figure 2 shows the distribution of the efficiency scores in each sector. The distribution of the entire sample shows a trend that the number of companies decreases as the efficiency score increases, except for the companies with extremely low efficiency. The corporate efficiency distribution of materials is close to a normal distribution, where there are many medium-level efficiency companies, while the numbers of companies decrease as the efficiency score becomes closer to 0 or 1. The industrial, consumer discretionary, consumer staple, health care and information technology sectors present similar right-skewed distributions, where most of the companies are concentrated in the low efficiency score interval. Conversely, the numbers of high efficiency companies in the financial, utilities and real estate sectors are much higher than those of companies with medium and low efficiency scores. The energy and telecommunication services have similar distributions, where firms with high and medium efficiency scores dominate the sector.

[Insert Figure 2 about here]

5.2 Corporate efficiency and ESG disclosure

The relationship between corporate efficiency and ESG disclosure was investigated, as illustrated in **Figure 3**. Assuming that there is no linear relationship between them, we used nonparametric regression analysis to explore the relationship between corporate efficiency and disclosure score. As shown in **Figure 3 (a)**, we found a positive relationship between corporate efficiency and the overall ESG score at the middle disclosure level, a strong negative relationship at the high disclosure level and a weak negative relationship at the low disclosure level. **Figure 3 (b)** shows that the E score also has a mixed relationship with corporate efficiency. At the low and middle disclosure levels, the E score presents an ascending trend with corporate efficiency. When the E score is greater than 75 points, corporate efficiency tends to decrease as the E score increases. For the S score, we found a weak negative relationship at the low disclosure level (**Figure 3 (c)**), similar to that for the ESG score. There is also a negative trend at the high disclosure level, but it is not reliable because of the wide confidence interval. As shown in **Figure 3 (d)**, the G score first shows a negative relationship with corporate efficiency. At the middle disclosure level, the positive relationship between the G score and corporate efficiency is the strongest among all three types of disclosures.

[Insert Figure 3 about here]

We further used piecewise linear regression to validate the relationship between corporate efficiency and ESG disclosure. The disclosure score was divided into quarters to test the strength of the relationship, where the low disclosure level is from 0 to 25 points, the lower-middle disclosure level is from 25 to 50 points, the upper-middle disclosure level is from 50 to 75 points and the high disclosure level is from 75 to 100 points. Moreover, the change of slope was tested by the coefficient equality test to distinguish the relationship at different disclosure levels. The results were consistent with the nonparametric regression analysis.

As shown in **Table 3**, the overall ESG score is negatively related to corporate efficiency when the ESG score is lower than 25 points. At the lower-middle disclosure level, the ESG score has a significant and positive effect on corporate efficiency. At the upper-middle disclosure level, the relationship becomes negative again but is not significant, while at the high disclosure level, corporate efficiency shows a significantly negative association with the ESG score. The nonlinear relationship implies that the degree of ESG information transparency results in different corporate efficiency effects. The information asymmetry problem may be associated with the low disclosure level. However, a high disclosure level may bring additional costs and more limitations for corporate operations. As a result, neither the low nor the high ESG information disclosure level has positive effects on corporate efficiency. In this case, only the moderate disclosure level has a positive effect on corporate efficiency.

As for the components of the ESG score, different trends are found for the different types of disclosures. In terms of the E score, at both the low and lower-middle disclosure levels, there is a significant and positive relationship between corporate efficiency and E score. However, the E score

is negatively related to corporate efficiency at the high disclosure level, and there is no significant association at the upper-middle disclosure level, which is the same trend seen with the overall ESG score. For the S score, the results at the low and middle disclosure levels are similar to those for the overall ESG score, i.e., there is a weak negative relationship at the low disclosure level and a positive relationship at the lower-middle disclosure level. However, we did not observe a significant relationship at either the high disclosure level or the upper-middle disclosure level. Since there are no observations at the high disclosure level for the G score, we only observed the results of the G score at low and middle disclosure levels. First, the G score presents a strong negative relationship with corporate efficiency at the low disclosure level. Then, the relationship becomes positive at the lower-middle disclosure level. At the upper-middle disclosure level, we observed a much stronger positive relationship for the G score, with the highest coefficient among all three types of disclosures. Furthermore, the coefficient equality test indicates that the two positive coefficients of the ascending trend are significantly different. Among all three disclosure types, either for positive or negative relationships, the G score has the strongest effect on corporate efficiency compared with the E and S scores. One possible explanation may be that governance information is more tightly related to corporate operations. Moreover, according to the research by Eccles et al. (2011), the global interest in governance information is greater than that in environmental and social information.

Overall, at different disclosure levels, mixed relationships exist between ESG disclosure and corporate efficiency. Meanwhile, common features can also be found through the comparison. First, a low disclosure level presents a negative relationship with corporate efficiency. A lack of disclosure brings about information asymmetry, which puts firms at a disadvantaged position in a rational market. One exception is environmental disclosure. Since the market is paying increasing attention to environmental problems, firms are encouraged to disclose environmental information, which was seldom done in the past. Even a low environmental information disclosure level enhances corporate reputation, which is associated with higher efficiency. Second, a high disclosure level also has a negative effect on corporate efficiency, as observed from the overall ESG score and the E score. Although environmental information disclosure is encouraged, a high disclosure level will expose much more unfavorable information. When a firm attempts to maintain a high disclosure level and good environmental performance in the long term, negative signals will destroy the corporate reputation. Corporate efficiency may also be affected by the additional cost of maintaining a high disclosure level. The third common feature is that for all types of disclosure, positive relationships are observed at the lower-middle disclosure level. Among these relationships, the coefficient of the G score is the highest, followed by the S and E scores. These results are consistent with the nonparametric regression analysis and prove our hypothesis that a positive relationship between ESG disclosures exists at certain disclosure levels. As shown in **Table 3**, this disclosure level is between 25 and 50 points. However, at the upper-middle disclosure level, only the G score has a significant and positive effect on corporate efficiency. The other types of disclosure have no significant relationship with corporate efficiency. At this disclosure level, the disadvantage of withholding information may be

offset by the benefit of disclosing information, especially for environmental and social information. Governance information still has a positive effect on corporate efficiency and is the strongest factor for companies at the upper-middle disclosure level, which implies that the importance of operation-related governance information is greater than that of environmental and social information. Based on these results, we conclude that our results support hypothesis 1(a) and hypothesis 1(b) regarding the nonlinear relationship and the strongest effect from governance disclosure.

[Insert Table 3 about here]

5.3 Corporate efficiency and ESG activities

Firms that adopt aggressive CSR strategies outperform their peers for several reasons, such as higher corporate reputation and favorable working conditions that attract productive employees (Turban and Greening, 1997) or enhanced competitiveness. In this section, we attempted to find the relationship between corporate efficiency and ESG activities. Through comparison with the results of ROA and market value, we also investigated the relationship between ESG activities and other financial performance indicators from the perspective of profitability and market expectation.

Environmental Activities

As shown in **Table 4**, we found that the verification type is significantly and positively related to corporate efficiency and market value, implying that companies with their environmental policies subject to an independent assessment tend to be more efficient and highly evaluated. The intense market competition encourages firms to employ more strategic environmental policies to enhance competitiveness. Since environmental policies have controversial impacts on CFP, the third-party assessment of environmental policy plays an important role in ensuring the policy's effectiveness and efficiency. This result implies the necessity of an independent assessment for corporate environmental policies.

We also observed that a green building policy is positively associated with both corporate efficiency and ROA. The efficiency score of firms that employed a green building policy is 0.036 higher than the score of firms that did not. Similarly, ROA is also higher if a firm takes steps towards using environmental technologies or principles in the design and construction of its buildings. In a typical office building, 30 percent of operating expense comes from energy consumption; it is the largest and most manageable operating expense in the provision of office space (Eichholtz et al., 2010). In the past decades, the economic return of having more energy-efficient and sustainable properties has stimulated the real estate market. Significant benefits are obtained by using green building properties, which include energy conservation, and meeting the shifting preferences of both tenants and investors with respect to environmental issues (Eichholtz et al., 2013). Furthermore, firms offering more updated and environmentally friendly office space are more likely to attract a better work force (Turban and Greening, 1997). This may also result in higher efficiency and profitability.

The results reveal a significant and negative relationship between corporate efficiency and environmental quality management policy as well as market value. Implementing a comprehensive environmental quality management strategy does not come without costs, such as prevention costs (costs of training employees), appraisal costs (costs of monitoring equipment), internal failure costs (costs of separating wastes) and external failure costs (costs of addressing hazardous emissions) (Chandrashekar et al., 1999). When adopting an environmental quality management policy, firms will also be impeded by the costs of shifting supply chain relationships and coping with moral problems (Miles and Russell, 1997). This is more likely to result in a negative relationship with corporate efficiency and profitability. The challenge is how to adopt an environmental quality management system more smoothly and enhance the efficiency of environmental quality management implementation. However, as one essential strategy of an environmental quality management policy, environmental supply chain management is positively related to corporate efficiency. Many studies have also found a positive link between corporate financial performance and green supply chains. As Rao and Holt (2005) explained, a green supply chain could be a source of competitiveness, which can improve corporate efficiency. Unlike green building policy, sustainable packaging is not significantly related to corporate efficiency, but firms that choose to use sustainable packaging are more likely to have higher ROA and market value.

Activities such as emissions reduction initiatives, climate change policy and discussion of climate change opportunities and risks and new products related to climate change and energy efficiency policy have no significant relationship with corporate efficiency, ROA or market value. From the point of view of stakeholder theory, the climate change issue is related to the largest number of stakeholders. However, in terms of the climate change issue, doing good does not mean doing well. Activities related to climate change are much less effective than activities that focus on corporate operational problems, such as a green building policy and a green supply chain. Henderson (2015) argued that for profit-maximizing firms, if the sustainable activities simply contribute to a public good, such as a climate change policy, this will put the firm at a competitive disadvantage. Although our result does not show a negative relationship, it indicates that firms with climate change policies are neither more nor less efficient.

According to the discussion above, as explained by the Porter hypothesis, environmental activities that present a positive association with CFP have some common features. Not all environmental policies will improve performance. This improvement occurs only if the policy aims to enhance environmental performance with any potential profit higher than the additional cost (Porter and Linde, 1995). In other words, our results support hypothesis 2, which states that activities that are cost cutting are positively related to corporate efficiency.

[Insert Table 4 about here]

Social Activities

As revealed in **Table 5**, equal opportunity and training policies are both positively associated with corporate efficiency and market value. Regarding corporate efficiency, the efficiency scores of firms with equal opportunity policies are 0.043 greater than those of other firms. The efficiency scores of firms that practice training programs are 0.048 greater than those of firms that do not. The results are consistent with an experiment-based study indicating that trained workers performed better than workers who did not participate in training programs (De Grip and Sauermann, 2012). Companies that adopt policies concerning employee career development and that offer equal work conditions may enhance their corporate reputation and attract more productive employees (Turban and Greening, 1997). Furthermore, many researchers have investigated the effect of on-the-job-training on productivity and have found a positive relationship between training programs and employee productivity (De Grip and Sauermann, 2013; Konings and Vanormelingen, 2015), which is also supported by our results.

In addition to equal opportunity and training policies, a human rights policy also has a positive relationship with market value, with a coefficient of 0.064, which is higher than that for the equal opportunity and training policies. A human rights policy aims to ensure the protection of the rights of all people involved with a company. Even though the benefits are not reflected by corporate efficiency and ROA, the market value reveals a positive relationship with this policy. While a policy that does not focus on operations but aims to create a more ideal corporate culture may have little connection with efficiency and profitability, such a policy would be well evaluated by the market. This is because it enhances corporate reputation and may indirectly lead to a better workplace.

As with environmental activities, social activities present controversial relationships with CFP. Practicing social activities involves costs; adopting a policy where the additional costs cannot be covered by the benefits may reduce profits and efficiency. As noted in **Table 5**, corporate efficiency is negatively related to having a health and safety policy. Moreover, employee CSR training does not have a positive relationship with CFP. These controversial results support hypothesis 3, which states that social activities that can enhance corporate reputation and attract able employees with little additional costs are positively related to corporate efficiency.

[Insert Table 5 about here]

Governance Activities

Governance activities consist of both stakeholder- and shareholder-oriented management strategies. As shown in **Table 6**, among the investigated global standard corporate governance regulations, including the United Nations Global Compact Signatory, Global Reporting Initiative (GRI) Criteria Compliance and Global Reporting Initiatives Checked, we found that only the United Nations Global Compact Signatory is positively related to corporate efficiency. Participants of the United Nations Global Compact are requested to practice ten principles covering four aspects of human rights, labor,

environment and anti-corruption. Most aspects of the ten principles and ESG activities overlap, such as human rights and equal opportunity policies and activities concerning environmental issues. Among these, a majority of the activities show non-negative relationships with corporate efficiency. Consistently, the relationship between the United Nations Global Compact Signatory and corporate efficiency is also significant and positive.

As for the other two global standards, no significant result is found with either corporate efficiency or market value. Regarding the GRI Criteria Compliance, companies are required to publish a sustainability report to enhance ESG management and decision-making. This type of nonfinancial reporting may target long-term management strategy and business plans, which is not reflected in our research. According to the results, the nonsignificant relationship implies that sustainability reporting has little linkage with financial performance. However, the negative relationship between GRI Criteria Compliance and ROA implies an obstacle to promoting sustainability reporting in the short run.

In terms of board composition, **Table 6** reveals that board independence has the strongest positive relationship with corporate efficiency and presents a significantly positive relationship with market value as well. From the perspective of shareholder theory, boards of directors take on the responsibility to solve agency problems. In large organizations, the CEO has incentives to keep his job and increase his own benefits from the position, which may harm the interests of shareholders. The negative relationship between executive compensation linked to ESG and ROA indicates the concern about the agency problem. Compensation related to nonfinancial objectives may lead to the CEO increasing his own benefits rather than enhancing the value of shareholders. Thus, there is an endogenous requirement of the board of directors to bargain with the CEO. Moreover, we have also observed that CEO duality is negatively related to corporate efficiency. The evidence implies that an independent board can put the board at a more advantageous bargaining position to replace an inefficient CEO and enhance corporate efficiency. However, our result also shows that CEO duality has a weakly positive relationship with ROA. The empirical evidence proved that CEO duality is a double-edged sword regarding financial performance (Firth et al., 2014). Hermalin and Weisbach (2003) proved that CEO turnover appears to be more sensitive to performance when the board is more independent. CEO duality makes it difficult to replace inefficient CEOs, while it strengthens a valuable board when the CEO performs well. By comparing the coefficients, the negative relationship is much stronger, implying that firms should be cautious regarding board composition and refrain from CEO duality when the CEO performs inefficiently.

As for the gender diversity of the board, the percentage of women on the board has no significant relationship with corporate efficiency. However, we found that the percentage of women on the board has a very strong positive linkage with ROA and market value. The coefficients are much greater than all the other activity variables. The positive relationship between gender diversity and firm performance has been proven by many other empirical results (Post and Byron, 2015). Our result is also consistent with the findings of Terjesen et al. (2016), who investigated 3800 global companies. There is little doubt that women on the board is the right direction and benefits female employees

realizing their potential, as well as eliminating gender discrimination in the workplace.

We also observed that audit committee meetings have a significant but extremely weak negative relationship with ROA. A business ethics policy for non-management or executive employees has no significant relationship with financial performance. Although ethical guidelines for employees are good practice, the effectiveness is limited if the policy is only implemented with nonexecutive employees. According to the discussion above, several activities regarding global sustainable strategies and board composition are positively related to CFP. The results support hypothesis 4, which states the positive effects of an independent and diversified board. Moreover, we also conclude that the United Nations Global Compact Signatory has a positive effect on corporate efficiency.

[Insert Table 6 about here]

Control variables

R&D expenditure is only significantly and positively associated with corporate efficiency. For ROA and market value, the coefficients of R&D expenditure are not statistically different from 0, which is consistent with the findings of Lee et al.(2016). Different from accounting- and market-based indicators, the corporate efficiency estimated by DEA methods is a total-factor productivity indicator, reflecting the technology of production and operations. R&D is the source of technological advancement. Thus, R&D expenditure is supposed to be directly related to the firm's productivity. Firm size is positively associated with corporate efficiency and ROA, while having a nonpositive relationship with market value. Financial leverage is only positively related to corporate efficiency and negatively related to ROA and market value. From the perspective of accounting, high financial leverage brings about high risk, which may deteriorate profitability and market value (Opler and Titman, 2009). For the three specifications of the environmental, social and governance activity analyses, the control variables present consistent results.

6. Conclusion and Policy Implication

In this study, we applied the DEA model to estimate corporate efficiency, a comprehensive CFP indicator, and then investigated the nonlinear relationship between corporate efficiency and ESG disclosure given different disclosure levels. We further explored the relationship of CFP, including corporate efficiency, ROA and market value, with environmental, social and governance activities.

Based on these analyses, we found that a moderate disclosure level of ESG information has a significant and positive effect on corporate efficiency, in contrast to the high or low disclosure level. To be specific, corporate efficiency and ESG disclosure have a positive relationship at the middle disclosure level, where most observations occur. Among the different disclosures, governance disclosure has the strongest positive relationship, followed by social disclosure and environmental disclosure. On the other hand, a low disclosure level has a negative association with corporate efficiency, except for environmental information disclosure, which reveals a weak positive relationship

with corporate efficiency. A high disclosure level also has a negative association with corporate efficiency, especially environmental disclosure. These results imply that the discretionary-based disclosure of ESG information has a complex association with corporate efficiency, rather than a simple linear relationship, given internal and external circumstances.

Furthermore, various kinds of CSR activities have been initiated to enhance corporate sustainability in the aspects of environmental, social and governance issues. Evidence from global companies proved that most of the ESG activities have non-negative relationships with corporate efficiency, ROA and market value. With respect to environmental activities, policies that are cost cutting, such as a green building policy, sustainable packaging, an environmental supply chain or adoption of independent assessment, are positively related to CFP. No significant results are found between climate change policies and CFP. For social activities, firms that try to reduce demographic discrimination and offer training programs equally tend to outperform their peers. In terms of governance activities, independent directors play an important role in reducing agency costs and maximizing shareholder value, which lead to better financial performance. Including women on the board also has a strong positive relationship with financial performance. Moreover, firms that participate in the United Nations Global Compact Signatory tend to be more efficient.

Overall, though mixed relationships are found in our results, the evidence shows that there is no doubt about the positive association between corporate efficiency and corporate sustainability for both ESG information disclosures and ESG activities. The nonlinear regression results clarify the complex relationship between corporate efficiency and ESG information disclosure. The ESG activity analyses indicate common features of activities that are positively related to CFP.

Based on our analyses, we make the following policy recommendations. First, firms are encouraged to disclose environmental and social information at a moderate level. Currently, corporate governance still plays the most important role in corporate management, rather than environmental and social issues. To enhance market competitiveness, disclosing more governance information is strongly recommended. Meanwhile, environmental and social information disclosure needs more managerial discretion. Firms that try little to disclose environmental and social information at a low disclosure level may face the resistance of poor CFP and fall into the low disclosure level and low efficiency trap. Our results suggest that one step forward will potentially make a difference. A strategic and moderate disclosure can enhance corporate efficiency, rather than a pro forma disclosure with limited transparency or over disclosure with much unfavorable information.

Second, the effective execution of ESG activities is essential to both CSR performance and CFP. According to the guidance on ESG-related risks published by COSO and the World Business Council for Sustainable Development (WBCSD) (COSO-WBCSD, 2018), in the business world, the awareness of ESG-related risks that were once considered as uncommon issues is becoming stronger than ever. However, firms can only symbolically conform to some environmental policies, such as climate change-related policies, without actual efforts to pursue the environmental goals (Haque and Ntim, 2018). Our results suggest that such climate change-related policies are also not beneficial from

the perspective of financial performance. In the future, to reduce or remove the impact of ESG-related risks and capture the potential profit opportunities, firms need to make more effort and be more effective in execution.

Third, the success of industry leaders can accelerate the spread of effective CSR strategies. Due to budget constraints, small and medium-sized enterprises (SMEs) may spend less R&D expenditure on ESG activities, especially on environmental issues, which need a large investment. From this aspect, industry leaders are in an advantageous position to try and determine effective CSR strategies, and SMEs could benefit from the spillover effect. Furthermore, government or nongovernment organizations can also help to strengthen industrial associations by holding workshops or seminars to increase the collaboration between firms that face similar ESG issues.

Further research should explore the causal relationship between CSR strategies and CFP to clarify what types of efforts firms can engage in to enhance CFP by doing good. Moreover, the response to CSR activities from stakeholders is also an important factor that might influence the CSR strategy choice of individual firms.

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Table 1. Descriptive statistics of main variables

Variables	#Obs.	Minimum	Maximum	Mean	Std. Dev.
Net Fixed Assets (million U.S. dollar)	6,631	0.0020	251,605	1,943	8,001
Employee (person)	6,631	2	2,200,000	13,678	46,938
COGS (million U.S. dollar)	6,631	0.0001	365,086	3,142	11,999
Revenue (million U.S. dollar)	6,631	0.0009	485,651	4,378	15,248
ESG score	6,615	2	83	22	13
E score	3,618	1	94	22	16
S score	4,389	3	91	27	15
G score	6,615	9	75	48	7

Notes: For estimating the corporate efficiency score more precisely, we selected the sample size as large as possible. After dropping missing values, the observations for the nonparametric regression analysis are less than the sample size for the corporate efficiency estimation. The statistical description for each sector is shown in Appendix Table 1.

Table 2. Descriptions of ESG Activities

Environmental Activities	Description
Verification Type	Indicates whether the company's environmental policies were subject to an independent assessment for the reporting period.
Green Building Policy	Indicates whether the company has taken any steps towards using environmental technologies and/or environmental principles in the design and construction of its buildings.
Sustainable Packaging	Indicates whether the company has taken any steps to make its packaging more environmentally friendly.
Environmental Quality Management Policy	Indicates whether the company has introduced any kind of environmental quality management and/or environmental management system to help reduce the environmental footprint of its operations.
Environmental Supply Chain Management	Indicates whether the company has implemented any initiatives to reduce the environmental footprint of its supply chain. Environmental footprint reductions could be achieved by reducing waste, by reducing resource use, by reducing environmental emissions, by insisting on the introduction of environmental management systems, etc. in the supply chain.
Climate Change Policy	Indicates whether the company has outlined its intention to help reduce global emissions of the Greenhouse Gases that cause climate change through its ongoing operations and/or the use of its products and services.
Climate Change Opportunities Discussed	Indicates whether the Management Discussion and Analysis (MD&A) and its equivalent section of the company's annual report discusses business opportunities related to climate change.
Risks of Climate Change Discussed	Indicates whether the Management Discussion and Analysis (MD&A) and its equivalent section of the company's annual report discusses business risks related to climate change.
Emissions Reduction Initiatives	Indicates whether the company has implemented any initiatives to reduce its environmental emissions to air
New Products - Climate Change	Indicates whether the company has developed and/or launched products, during the current period only, which address future impacts of climate change and/or which mitigate customers' contributions to climate change by reduced Green House Gas (GHG) emissions. The products may or may not be new to the market.
Energy Efficiency Policy	Indicates whether the company has implemented any initiatives to make its use of energy more efficient.
Social Activities	Description
Equal Opportunity Policy	Indicates whether the company has made a proactive commitment to ensure non-discrimination against any type of demographic group.
Human Rights Policy	Indicates whether the company has implemented any initiatives to ensure the protection of the rights of all people it works with.
Training Policy	Indicates whether the company has implemented any initiatives to train new and existing employees on career development, education or skills. Training initiatives should apply to all employee levels, not just to those employees at management level.
Employee CSR Training	Discloses whether the company conducts training courses for employees on Corporate Social Responsibility (CSR).
Health and Safety Policy	Indicates whether the company has recognized its health and safety risks and responsibilities and is making any effort to improve the management of employee health and/or employee safety.
Fair Remuneration Policy	Indicates if the company has demonstrated a group wide commitment to ensure payment of a fair (could be defined as minimum, living, or some other criteria) wage to all Group employees, even in those countries that do not legally require a minimum wage.
Governance Activities	Description
UN Global Compact Signatory	Indicates whether the company is a signatory of the United Nations Global Compact.
GRI Criteria Compliance	Indicates whether the company is in compliance with Global Reporting Initiative (GRI) criteria.
Global Reporting Initiatives Checked	Indicates whether the company's application level was checked by the Global Reporting Initiative (GRI).
% Independent Directors	Independent directors as a percentage of total board membership.
CEO Duality	Indicates whether the company's Chief Executive Officer is also Chairman of the Board, as reported by the company.
Audit Committee Meetings	Number of meetings of the Board's Audit Committee during the reporting period. In the case of Japanese companies, this number will reflect the number of audit committee meetings for those companies with a committee based structure, or the number of board of auditor meetings for those companies with a board of auditor based structure.
% Women on Board	Percentage of women on the Board of Directors, as reported by the company.
Executive Compensation Linked to ESG	Indicates whether executive compensation is linked to environmental, social and governance (ESG) goals.
Business Ethics Policy	Indicates whether the company has established ethical guidelines and/or a compliance policy for its non-management/executive employees in the conduct of company business.

Table 3. Piecewise Linear Fitting Result of Corporate Efficiency and ESG Disclosure score

Piecewise Interval of ESG Disclosure Score		Coefficient			
		ESG score	E score	S score	G score
[1]	0~25	-0.0010* (0.0006)	0.0034*** (0.0006)	-0.0019*** (0.0006)	-0.0167* (0.0088)
[2]	25~50	0.0055*** (0.0005)	0.0013** (0.0006)	0.0037*** (0.0005)	0.0051*** (0.0007)
[3]	50~75	-0.0002 (0.0021)	0.0003 (0.0017)	-0.0007 (0.0014)	0.0104*** (0.0009)
[4]	75~100	-0.0200*** (0.0078)	-0.0090** (0.0041)	0.0123 (0.0100)	(Omitted)
	RD	0.0072*** (0.0007)	0.0061*** (0.0006)	0.0068*** (0.0006)	0.0071*** (0.0007)
	Firm size	-0.0033 (0.0023)	0.0246*** (0.0030)	0.0191*** (0.0028)	-0.0068*** (0.0022)
	Leverage	0.0373*** (0.0031)	0.0409*** (0.0046)	0.0384*** (0.0041)	0.0357*** (0.0031)
	Sector	YES	YES	YES	YES
	R-squared	0.2854	0.346	0.3166	0.3048
	#Obs.	6,424	3,552	4,284	6,424
Coefficient Equality Test		F-statistics			
	[1] – [2]	46.91***	3.35*	32.66***	6.03**
	[2] – [3]	5.97**	0.26	6.6**	17.02***
	[3] – [4]	4.08**	3.22*	1.55	(Omitted)

Notes: The disclosure scores are quartered into four equal splines, named low disclosure level [1], lower-middle disclosure level [2], upper-middle disclosure level [3] and high disclosure level [4]. The first part of the table shows the result of the piecewise linear regression. The second part of the table lists the result of the coefficient equality test for each adjacent spline. Significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Relationships between environmental activities and corporate efficiency, ROA and Market Value

Variables	Corporate Efficiency	ROA	Market Value
Verification Type	0.042*** (0.012)	-0.002 (0.004)	0.082** (0.036)
Green Building Policy	0.036*** (0.010)	0.005* (0.003)	0.015 (0.033)
Sustainable Packaging	0.005 (0.010)	0.006* (0.003)	0.082** (0.033)
Environmental Quality Management Policy	-0.025*** (0.008)	0.006 (0.004)	-0.116*** (0.028)
Environmental Supply Chain Management	0.025*** (0.009)	0.000 (0.004)	0.010 (0.029)
Climate Change Policy	0.005 (0.010)	0.001 (0.004)	0.028 (0.032)
Climate Change Opportunities Discussed	0.008 (0.029)	0.004 (0.007)	-0.146 (0.107)
Risks of Climate Change Discussed	0.003 (0.014)	-0.010 (0.007)	0.017 (0.033)
Emissions Reduction Initiatives	0.006 (0.012)	-0.008 (0.008)	0.052 (0.038)
New Products - Climate Change	-0.001 (0.028)	0.002 (0.009)	0.013 (0.095)
Energy Efficiency Policy	-0.010 (0.013)	-0.001 (0.009)	0.008 (0.044)
R&D Expenditure	0.005*** (0.001)	0.000 (0.000)	0.001 (0.001)
Firm Size	0.015*** (0.003)	0.008*** (0.001)	-0.034*** (0.010)
Leverage	0.031*** (0.005)	-0.017*** (0.002)	-0.127*** (0.016)
Sector	YES	YES	YES
Country	YES	YES	YES
#Obs.	3,604	3,393	3,560
R2	0.440	0.133	0.371

Notes: The table shows how environmental activities are related to corporate efficiency, ROA and Market Value. The significance levels are indicated as follows:

*** p<0.01, ** p<0.05, * p<0.1.

Table 5. Relationships between social activities and corporate efficiency, ROA and Market Value

Variables	Efficiency	ROA	Market Value
Equal Opportunity Policy	0.043*** (0.009)	0.001 (0.003)	0.050* (0.029)
Human Rights Policy	-0.008 (0.009)	-0.001 (0.004)	0.064** (0.030)
Training Policy	0.048*** (0.010)	-0.001 (0.005)	0.058* (0.033)
Employee CSR Training	-0.004 (0.011)	-0.005** (0.002)	-0.020 (0.036)
Health and Safety Policy	-0.031*** (0.011)	-0.001 (0.003)	0.040 (0.036)
Fair Remuneration Policy	0.006 (0.043)	-0.006 (0.018)	0.141 (0.144)
R&D Expenditure	0.006*** (0.001)	0.000 (0.000)	0.001 (0.001)
Firm Size	0.016*** (0.003)	0.009*** (0.001)	-0.040*** (0.009)
Leverage	0.030*** (0.004)	-0.017*** (0.002)	-0.117*** (0.016)
Sector	YES	YES	YES
Country	YES	YES	YES
#Obs.	3,677	3,451	3,629
R2	0.435	0.129	0.367

Notes: The table shows how social activities are related to corporate efficiency, ROA and Market Value. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Relationships between governance activities and corporate efficiency, ROA and Market Value

Variables	Efficiency	ROA	Market Value
UN Global Compact Signatory	0.029* (0.015)	0.001 (0.004)	0.044 (0.041)
GRI Criteria Compliance	0.014 (0.010)	-0.014*** (0.004)	-0.003 (0.029)
Global Reporting Initiatives Checked	-0.058 (0.053)	0.011 (0.030)	-0.232 (0.293)
% Independent Directors	0.118*** (0.037)	0.003 (0.011)	0.258** (0.113)
CEO Duality	-0.015* (0.001)	0.009*** (0.000)	-0.014 (0.004)
Audit Committee Meetings	0.001 (0.009)	-0.001*** (0.003)	-0.005 (0.029)
% Women on Board	0.061 (0.048)	0.051*** (0.017)	0.597*** (0.172)
Executive Compensation Linked to ESG	0.007 (0.019)	-0.025** (0.011)	0.015 (0.048)
Business Ethics Policy	0.020 (0.020)	-0.001 (0.006)	-0.031 (0.074)
R&D Expenditure	0.005*** (0.001)	0.000 (0.000)	0.001 (0.001)
Firm Size	0.022*** (0.004)	0.009*** (0.001)	-0.012 (0.012)
Leverage	0.033*** (0.005)	-0.015*** (0.002)	-0.081*** (0.019)
Sector	YES	YES	YES
Country	YES	YES	YES
#Obs.	2,443	2,287	2,426
R2	0.447	0.186	0.345

Notes: The table shows how governance activities are related to corporate efficiency, ROA and Market Value. The significance levels are indicated as follows: *** p<0.01, ** p<0.05, * p<0.1.

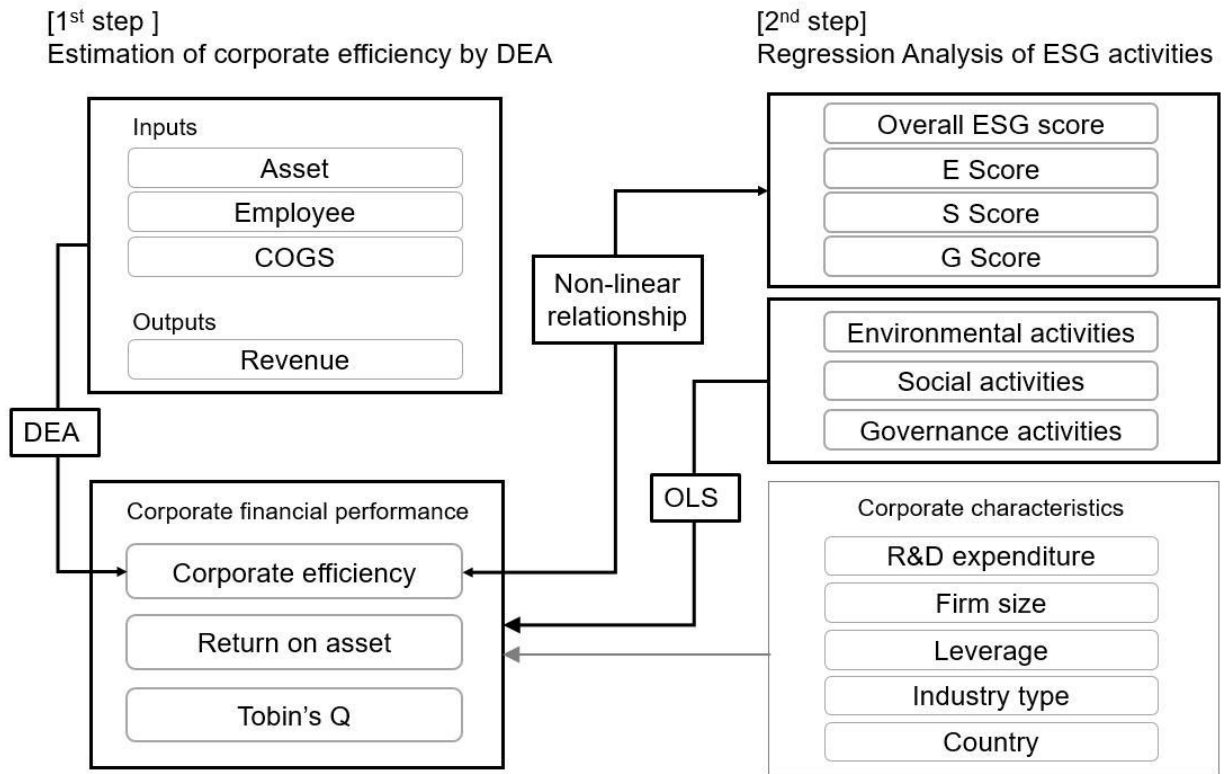
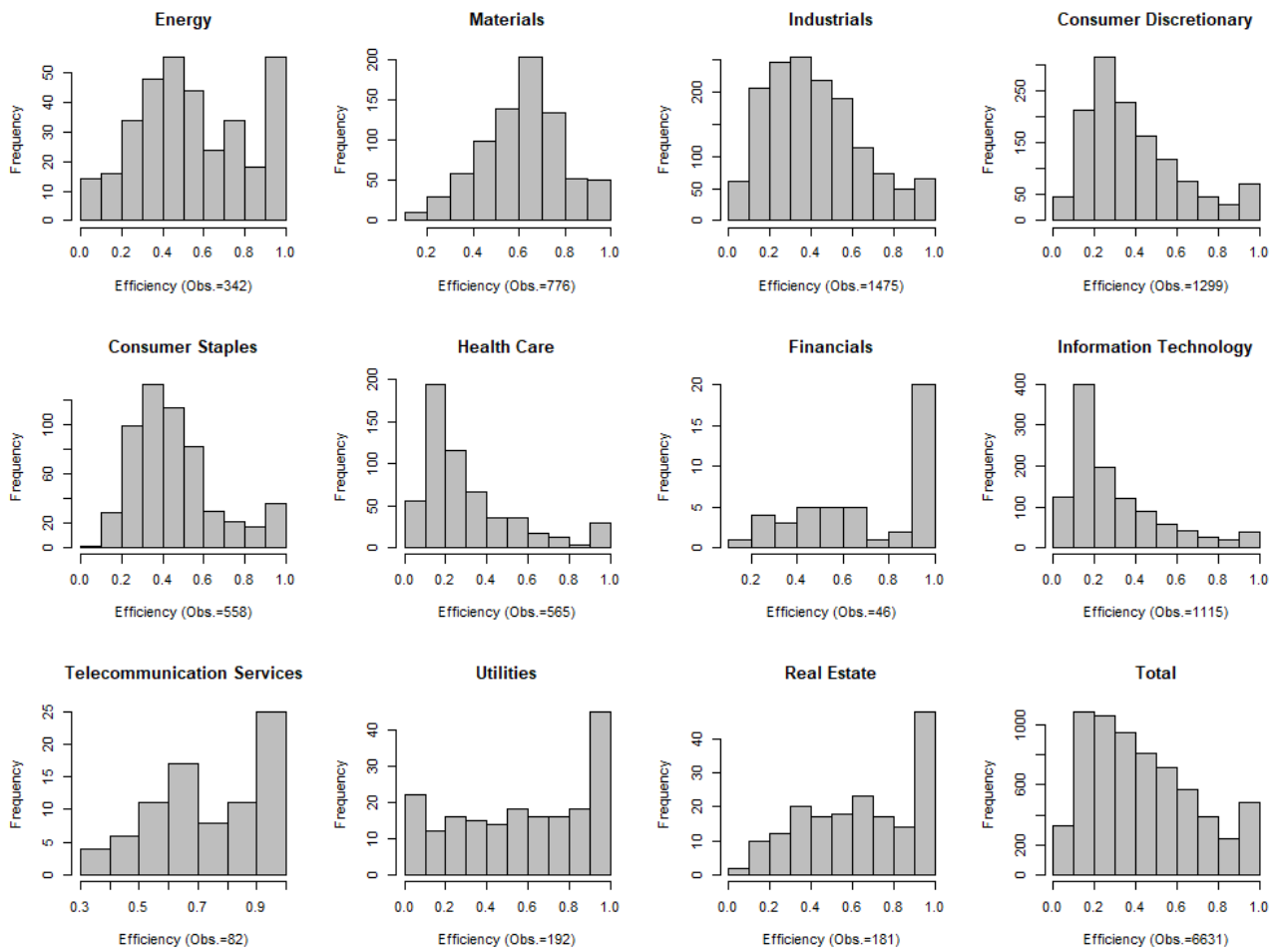
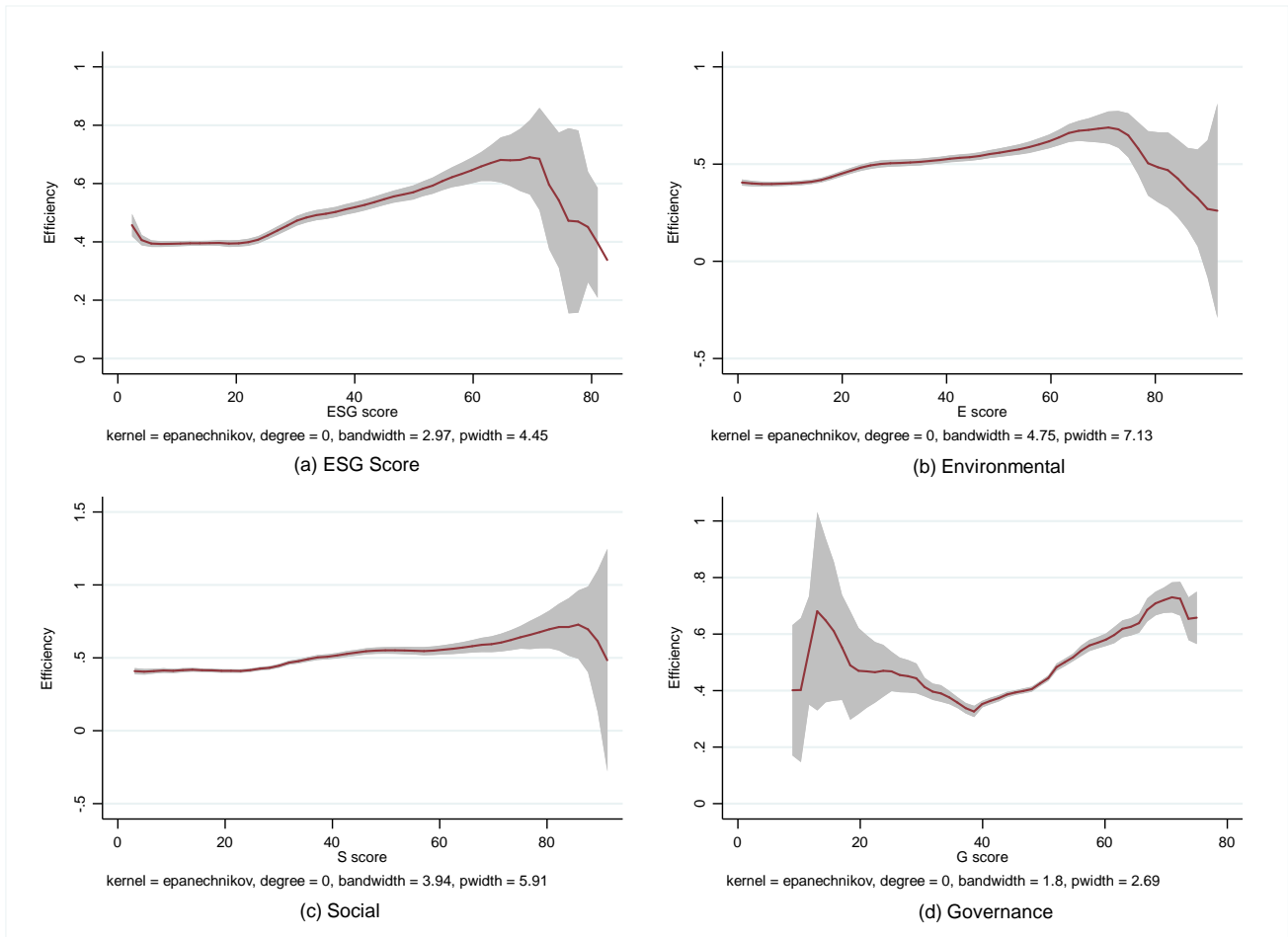


Figure 1. Research framework of this study



Notes: Corporate efficiency of 11 sectors is estimated by using the input-oriented DEA model. The efficiency score ranges from 0, indicating the least efficient to 1, indicating the most efficient. Given a sector's heterogeneity, we estimated the efficiency score by sector. Most observations come from the U.S. (2030 Obs.), Japan (1908 Obs.) and China (1042 Obs.).

Figure 2. Corporate Efficiency by Sectors



Notes: The figures present nonparametric regression results between corporate efficiency and ESG score (a, Obs. =6556), Environmental (b, Obs. =3618), Social (c, Obs. =4389), Governance (d, Obs. =6615) disclosure scores, respectively. The disclosure score ranges from 0.1 to 100 and 100 points indicates full disclosure of all the ESG items. Corporate efficiency ranges from 0 to 1, and 1 point is the best.

Figure 3. Relationship between corporate efficiency and ESG scores

Appendix

Table S1. Descriptive statistics of financial variables and ESG disclosure scores by sectors

Sectors (# of firms)	Variables	Min	Max	Mean	Std. Dev.
Energy (342)	Net Fixed Assets (million U.S. dollar)	4.64	251,605	8,127	23,971
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.02	222,739	6,422	22,902
	Revenue (million U.S. dollar)	0.01	264,960	7,765	26,154
Materials (776)	Net Fixed Assets (million U.S. dollar)	0.00	61,278	2,149	4,952
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.35	166,982	2,784	8,004
Industrials (1475)	Revenue (million U.S. dollar)	0.13	170,497	3,403	8,819
	Net Fixed Assets (million U.S. dollar)	0.08	54,095	1,100	3,238
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.15	122,721	2,916	8,210
Consumer Discretionary (1299)	Revenue (million U.S. dollar)	0.51	135,069	3,730	9,990
	Net Fixed Assets (million U.S. dollar)	0.08	77,497	1,323	5,127
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.58	199,680	3,313	12,592
Consumer Staples (558)	Revenue (million U.S. dollar)	3.55	248,983	4,657	15,840
	Net Fixed Assets (million U.S. dollar)	0.00	116,655	1,612	5,879
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.03	365,086	5,010	19,391
Health Care (565)	Revenue (million U.S. dollar)	0.00	485,651	7,053	25,492
	Net Fixed Assets (million U.S. dollar)	0.04	18,479	646	1,953
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.00	167,634	2,670	12,665
Financials (46)	Revenue (million U.S. dollar)	0.21	179,045	4,319	15,420
	Net Fixed Assets (million U.S. dollar)	0.06	145,166	4,673	21,907
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	3.93	157,051	4,738	23,103
Information Technology (1115)	Revenue (million U.S. dollar)	3.30	210,821	7,041	30,945
	Net Fixed Assets (million U.S. dollar)	0.04	31,858	493	2,099
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.02	140,089	1,779	7,540
Telecommunication Services (82)	Revenue (million U.S. dollar)	0.04	233,715	2,754	11,188
	Net Fixed Assets (million U.S. dollar)	2.79	124,450	9,427	20,959
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	24.19	67,046	6,584	14,106
Utilities (192)	Revenue (million U.S. dollar)	46.99	146,801	12,990	27,618
	Net Fixed Assets (million U.S. dollar)	0.75	75,709	8,719	13,664
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.33	47,151	2,561	5,331
Real Estate (181)	Revenue (million U.S. dollar)	0.30	51,055	4,623	7,666
	Net Fixed Assets (million U.S. dollar)	0.23	44,883	3,413	6,913
	Employee (person)	2	95,498	7,616	15,825
	COGS (million U.S. dollar)	0.16	28,122	1,860	3,842
	Revenue (million U.S. dollar)	0.93	31,270	2,552	4,878

Table S2. Descriptive statistics of environmental activities variables

Dependent variables	Mean			Std. Dev.			Min			Max		
	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value
	0.448	0.030	0.131	0.261	0.085	0.799	0.013	-2.373	-5.625	1	0.431	3.405
Independent & Control variables	Mean			Std. Dev.			Min			Max		
R&D Expenditure	1.544	1.596	1.560	7.735	7.952	7.781	0	0	0	151.094	151.094	151.094
Firm Size	8.536	8.562	8.543	1.606	1.597	1.605	2.079	2.079	2.079	14.604	14.604	14.604
Leverage	0.010	0.034	0.013	0.960	0.945	0.958	-4.459	-4.459	-4.459	6.175	6.175	6.175
Verification Type	0.124	0.128	0.125	0.329	0.334	0.331	0	0	0	1	1	1
Green Building Policy	0.714	0.723	0.713	0.452	0.448	0.452	0	0	0	1	1	1
Sustainable Packaging	0.168	0.169	0.169	0.374	0.374	0.375	0	0	0	1	1	1
Environmental Quality Management Policy	0.561	0.571	0.560	0.496	0.495	0.497	0	0	0	1	1	1
Environmental Supply Chain Management	0.563	0.571	0.564	0.496	0.495	0.496	0	0	0	1	1	1
Climate Change Policy	0.006	0.007	0.006	0.080	0.082	0.080	0	0	0	1	1	1
Climate Change Opportunities Discussed	0.081	0.082	0.082	0.273	0.274	0.274	0	0	0	1	1	1
Risks of Climate Change Discussed	0.011	0.011	0.011	0.102	0.102	0.103	0	0	0	1	1	1
Emissions Reduction Initiatives	0.779	0.788	0.779	0.415	0.409	0.415	0	0	0	1	1	1
New Products - Climate Change	0.146	0.146	0.147	0.353	0.354	0.354	0	0	0	1	1	1
Energy Efficiency Policy	0.376	0.380	0.378	0.484	0.486	0.485	0	0	0	1	1	1

Table S3. Descriptive statistics of social activities variables

Dependent variables	Mean			Std. Dev.			Min			Max		
	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value
	0.448	0.030	0.135	0.261	0.085	0.801	0.013	-2.373	-5.625	1.000	0.431	3.405
Independent & Control variables	Mean			Std. Dev.			Min			Max		
R&D Expenditure	1.532	1.585	1.549	7.668	7.894	7.717	0	0	0	151.094	151.094	151.094
Firm Size	8.522	8.550	8.530	1.610	1.603	1.609	2.079	2.079	2.079	14.604	14.604	14.604
Leverage	0.012	0.037	0.016	0.964	0.951	0.964	-4.459	-4.459	-4.459	6.175	6.175	6.175
Health and Safety Policy	0.811	0.812	0.811	0.391	0.391	0.392	0	0	0	1	1	1
Equal Opportunity Policy	0.623	0.619	0.625	0.485	0.486	0.484	0	0	0	1	1	1
Human Rights Policy	0.617	0.624	0.614	0.486	0.485	0.487	0	0	0	1	1	1
Training Policy	0.748	0.757	0.746	0.434	0.429	0.435	0	0	0	1	1	1
Employee CSR Training	0.092	0.096	0.093	0.290	0.295	0.291	0	0	0	1	1	1
Fair Remuneration Policy	0.005	0.006	0.005	0.072	0.074	0.072	0	0	0	1	1	1

Table S4. Descriptive statistics of governance activities variables

Dependent variables	Mean			Std. Dev.			Min			Max		
	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value	Efficiency	ROA	Market Value
	0.490	0.033	0.048	0.255	0.075	0.770	0.018	-1.218	-5.625	1	0.346	3.210
Independent & Control variables	Mean			Std. Dev.			Min			Max		
R&D Expenditure	1.855	1.916	1.865	8.340	8.591	8.368	0	0	0	125.4	125.4	125.4
Firm Size	8.709	8.726	8.710	1.592	1.593	1.594	2.303	2.303	2.303	14.604	14.604	14.604
Leverage	0.066	0.090	0.070	0.951	0.942	0.951	-3.908	-3.908	-3.908	6.175	6.175	6.175
GRI Criteria Compliance	0.291	0.299	0.291	0.455	0.458	0.454	0	0	0	1	1	1
Global Reporting Initiatives Checked	0.004	0.004	0.004	0.061	0.063	0.061	0	0	0	1	1	1
UN Global Compact Signatory	0.116	0.117	0.116	0.320	0.321	0.321	0	0	0	1	1	1
% Independent Directors	0.471	0.459	0.471	0.292	0.290	0.292	0	0	0	1	1	1
% Women on Board	0.110	0.108	0.110	0.120	0.119	0.119	0	0	0	0.667	0.667	0.667
Audit Committee Meetings	0.498	0.500	0.498	0.500	0.500	0.500	0	0	0	1	1	1
CEO Duality	8.882	8.963	8.901	4.600	4.662	4.602	1	1	1	41	41	41
Business Ethics Policy	0.862	0.860	0.865	0.345	0.347	0.342	0	0	0	1	1	1
Executive Compensation Linked to ESG	0.071	0.070	0.071	0.257	0.256	0.257	0	0	0	1	1	1