The Effect of ESG on Management Efficiency: Focusing on the Moderating Effect of the Firm Size
ESG가 경영효율성에 미치는 영향: 기업규모의 조절효과를 중심으로

Sangpil Yoon(First Author)
KAIST
(*etona@kaist.ac.kr*)
Dongphil Chun(Corresponding Author)
Pukyong National University
(*performance@pknu.ac.kr*)

As the economy and society grow and environmental pollution and social problems emerge, firm's interest in ESG and sustainable management is increasing. Against this background, corporates are making efforts to disclose their ESG activities, and the government is moving to establish standards and obligations for corporate ESG disclosure. In order to give justification to ESG activities, academia is conducting research to reveal the effect of ESG activities on performance. Therefore, this study analyzed the effect of ESG on management efficiency. For this, the ESG grade of the Korea Corporate Governance Service, DEA, and Tobit regression were used. As a result of the analysis, it was found that the higher the ESG grade, the lower the management efficiency. This negative (-) relationship was moderated in the positive (+) direction as the firm size increased. This means that ESG activities can be negative in terms of efficiency. It also indicates that the impact of ESG may vary depending on the characteristics of the corporate. This study has academic implication in that it extends ESG-related research to the aspect of efficiency. In addition, it has practical implications that factors to consider are provided to policy makers and corporate decision makers.

Key Words: ESG, Management efficiency, DEA, Tobit regression

Ⅰ. Introduction

Recently, as the economy and society grow, various problems such as climate change, lack of jobs, and economic and other inequalities are occurring at the same time. With the occurrence of these social problems, not only the government but also corporates are gradually being given social responsibility (Auld et al, 2008). In order to prove these social problems, many countries are interesting and

Submission Date: 07. 16. 2022 Revised Date: (1st: 08. 19. 2022) Accepted Date: 08. 23. 2022

focusing Sustainable Development Goals (SDGs) (Robert et al, 2005), and the concept of Environment, Society, and Governance (ESG) is becoming a hot topic within corporates in the world (Amel-Zadeh & Serafeim, 2018; Li et al, 2021).

ESG represents activity indicators for sustainable management of corporates, including responding to climate change and solving social problems (Amel-Zadeh & Serafeim, 2018). As intangible assets are recognized more important than tangible assets among the components determining the value of a corporate, the importance of non-financial information disclosure such as ESG is increasing rapidly (Bae et al, 2021). Including International Sustainability Standards Board (ISSB), ESG-related international organizations are establishing unified measurement and disclosure indicators, and each country is institutionalizing for the rapid growth of ESG (Lee, 2022). This movement has been proven to be effective in research data that the return on investment with ESG in mind is superior to that of other investments (Kim et al, 2013; Min & Kim, 2019; Oh & Lee, 2019; Park, 2017). In other words, experts are gradually agreeing on the perception and necessity of ESG in countries around the world.

Most of the preceding studies related to ESG focused on the overall ESG grade or the improvement of financial performance or corporate value (Gillan et al, 2021; Vishwanathan et al, 2020). Since then, studies have been attempted to examine the moderating effect in the relationship between ESG and corporate performance around 2020 (Jung & Kang, 2020; Kim, 2020; Kim et al, 2021). However, most previous studies focused on the absolute financial performance or its effectiveness based on market capitalization. Revenue growth, ROA, ROE, cash flow, Tobin′s q, Bond value, and return were mainly used as dependent variables for ESG studies (Gillan et al, 2021). Research to identify factors that affect the corporate's performance is not only from the viewpoint of effectiveness but also from the viewpoint of efficiency. Contrary to this, there are no studies that consider performance as efficiency in papers analyzing the effect of ESG on performance. Since corporate's resources must be used for ESG activities, it is necessary to study ESG in terms of efficiency considering costs and inputs.

Therefore, this study attempted to examine the effect of ESG on corporate performance in terms of efficiency. To this end, the relationship with ESG was analyzed by calculating the management efficiency of a corporate through Data Envelopment Analysis (DEA). In addition, the effect of the firm size on ESG and management efficiency was analyzed by setting the firm size as a moderator. Through this, this study will expand the research on the impact of ESG to the efficiency aspect and provide corporate managers with factors to

consider for ESG activities and sustainable management. In addition, it will confirm that the impact varies depending on the firm size and provide implications for the ESG strategy according to the characteristics of the corporate.

This study consists of the following. Section Ⅱ presents hypotheses by reviewing previous studies related to corporate management efficiency and ESG. Section Ⅲ shows the research model, variable setting, and measurement method, and Section Ⅳ summarizes the results of empirical analysis. In Section Ⅴ, the discussion and implications will be presented based on the results of the empirical analysis.

Ⅱ. Literature Review and Hypothesis

2.1 ESG and Corporate Performance

Corporate sustainability management disclosure is becoming a global trend in response to environmental problems and climate change, including the 2015 Paris Climate Agreement. In Korea, the Financial Services Commission said in 2021 that companies with total assets of more than 2 trillion KRW will be required to disclose sustainable management reports after 2025 and that it will expand to all KOSPI listed companies after 2030. As such, ESG is progressively recognized as necessary in the field. Against this background, several studies have been conducted to reveal the relationship between ESG and corporate performance to clarify the justification for ESG.

Research to reveal the relationship between ESG and corporate performance was conducted in two aspects. The first is the relationship between ESG and corporate value in the market. In Lee & Kim(2015), a positive (+) relationship was found as a result of analyzing the relationship between the ESG grade and the corporate value using the KEJI index of 780 listed companies. Lim(2016) analyzed the relationship between ESG grades and corporate value for 975 listed companies with ESG grades B+ or higher between 2011 and 2014 and revealed that ESG overall, environmental, and social grades had a positive (+) correlation with Tobin′s Q. In a study by Leem(2019) using 2,507 companies, it was confirmed that ESG overall, society, and governance grade had a positive effect on Tobin′s Q. As such, a corporate's ESG activities are considered an element of sustainable management and they are evaluated positively in the market.

In addition, there are numerous previous studies that revealed the relationship between ESG and financial performance. Son(2016) compared 159 companies selected for the KEJI 200 with 288 other companies, and found that the selected companies had better financial ratios corresponding to growth, stability, and liquidity, and improved economic performance for the next year. Kim & Min(2016) analyzed

the forward-following relationship between ESG grade and financial performance. As a result of the analysis, non-financial performance such as ESG grade improves the efficiency of the supply chain to improve profitability. It was argued that there is a positive cycle between capacity increase and non-financial performance through continuous investment.

In summary, ESG can be seen as having a positive effect on corporate financial performance and increasing corporate value. As a result, it will increase the management efficiency by increasing the company's sales or net profit. Accordingly, the following hypothesis was established.

Hypothesis 1: The higher the ESG overall grade of a company, the higher the management efficiency.

Hypothesis 1-1: The higher the environmental grade of a company, the higher the management efficiency.

Hypothesis 1-2: The higher the social grade of a company, the higher the management efficiency.

Hypothesis 1-3: The higher the governance grade, the higher the management efficiency.

2.2 ESG and Firm Size

ESG activities do not work equally positively for all companies. In some studies, ESG and yields were inversely proportional, or a negative (-) relationship was confirmed in the case of Chinese state-owned enterprises (Yang et al, 2020; Yi, 2020). Accordingly, it is necessary to check the moderating effect of corporate characteristics on the relationship between ESG and corporate performance.

Cappucci(2018), who analyzed the negative effects of ESG, argued that when ESG first entered the portfolio, there was a paradox that the increase in profits was insignificant and the initial negative effects were caused by the increase in costs. In other words, this means that the impact on corporate performance varies depending on the maturity of ESG. In Korea, ESG activities are conducted mainly by large companies. According to Kim & Min (2016), non-financial performance was high in large, profitable companies and tended to invest in the long term. In a study by Son (2016), it was said that the life cycle of a company that mainly performs ESG activities corresponds to the growth period and maturity period. In addition, the study revealed that the more companies actively perform ESG, the better their economic performance in the next year. Because small enterprises lack funds compared to large enterprises, they generally do not have a dedicated CSR department and tend to engage in CSR activities only on major issues (Brammer & Millington, 2006). In the case of ESG, SMEs lack financial and professional manpower for ESG, so most ESG activites are mainly made by large enterprises

(Kim, 2021).

In this respect, investment and aggressiveness in ESG varies according to the size of the company, and this will indicate a difference in the maturity of ESG. Therefore, firm size may be a moderating variable controlling the relationship between ESG and performance. In this regard, Na & Hong(2011) found that CSR activities have different effects on corporate value depending on the firm size. Also, Aouadi & Marsat(2018) stated that the larger the firm size, the greater the impact of CSR performance on corporate value. ESG also has a major impact on corporate value in large and medium-sized enterprises among large medium, and small enterprises (Park & Shin, 2021).

In summary, the larger the size of the company, the longer the investment in ESG may continue, so that the maturity of ESG may differ. This difference in ESG maturity can adjust the effect on corporate performance. Accordingly, the following hypotheses are established.

Hypothesis 2: The larger the firm size, the more positive the relationship between ESG overall grade and management efficiency is.

Hypothesis 2-1: The larger the firm size, the more positive the relationship between environmental grade and management efficiency is.

Hypothesis 2-2: The larger the firm size, the more positive the relationship between social grade and management efficiency is.

Hypothesis 2-3: The larger the firm size, the more positive the relationship between governance grade and management efficiency is.

2.3 Management Efficiency

Efficiency is generally expressed as a ratio of input and output, and even companies that utilize the same input level may experience performance differences due to differences in efficiency (Kim & Lee, 2003). For this reason, efficiency is analyzed as an important indicator in various fields, and based on this, it is used for identifying the cause of the problem, establishing strategies, and improving performance.

In order to measure efficiency, it is important to determine the output variable representing the performance of the group and the input variable used for it. Therefore, the variables used for measuring efficiency differ depending on the characteristics and fields of the group. For example, in the case of airlines, Lee & Seo(2017), the number of available seats, available weight, aircraft, and employees were used as input variables, revenue passenger kilometers, revenue ton kilometers, and sales cost were measured as intermediate variables, and efficiency was measured by the airline's sales. Park(2015) measured the efficiency of agricultural-related public serv-

ices with number of employees, area, and total budget as input variables and the number of customers participating in the service, the number of new product development, and the average income of farmers as output variables.

As the example discussed above, in the case of a specific field group, the output and inputs according to the purpose of operation are clear. However, it is difficult for a general company to specify inputs and outputs because outputs or inputs differ depending on the purpose of management even in the same field, the relationship between inputs and outputs is ambiguous and complicated, or because it operates several businesses at the same time. For this reason, various definitions and variables were used in previous studies related to management efficiency.

In addition to management efficiency, names such as operational efficiency, corporate efficiency, cost efficiency, and financial efficiency were used in research on efficiency related to corporate management. In this study, this was unified into management efficiency. Ha & Choi(2018) measured the management efficiency of Korean automobile firms by using total assets, total capital, number of employees, sales, and net income, and found that the relationship between technological innovation activity and management efficiency was inverted U shaped. Sin(2019) presented a three-dimensional DEA model that considers input assets and procured capital to measure the management efficiecny. In this case, total assets, total capital, sales, net income, and EBITDA were used as variables for efficiency. Ahn et al.(2020) analyzed the management efficiency of small and medium-sized enterprises that manufacture telecommunications and broadcasting equipment. At this time, the input variables were total assets, total capital, number of employees, salary, R&D expenses, and entertainment expenses, and the output variables were sales and net income. Ma & Lee(2021) measured the efficiency of global ICT companies by using the input variables as equity, total debt, and number of employees and dividing management efficiency into operating efficiency with sales, net income, and market capitalization, profit efficiency with net income, and market efficiency with sales. Shin et al.(2021) set the input variable of management efficiency as tangible assets, intangible assets, cost of sales, and sales and administrative expenses that can be made at the managerial discretion, and set the output variable as sales. In a study by Woo et al.(2021), changes in management efficiency were analyzed for smart mobile companies, with total assets, equity, and number of employees as input variables and sales as output variables. Son & Yoon(2022) analyzed the management efficiency of companies in the smart grid industry as input variables of total assets and total capital, and sales and net income as output variables.

〈Table 1〉 Measurement of management efficiency

Authors	Input	Output
Ha & Choi(2018)	- Total assets - Total capital - Number of employees	- Sales - Net income
Sin(2019)	- Total assets - Total capital	- Sales - Net income - EBITDA
Ahn et al.(2020)	- Total assets - Total capital - Number of employees - Salary - R&D expenses - Entertainment expenses	- Sales - Net income
Ma & Lee(2021)	- Equity - Total debt - Number of employees	- Sales - Net income - Market capitalization
Shin et al.(2021)	- Tangible assets - Intangible assets - Cost of sales - Sales and administrative expenses	- Sales
Woo et al.(2021)	- Total assets - Equity - Number of empolyees	- Sales
Son & Yoon(2022)	- Total assets - Total capital	- Sales - Net income

Table 1 summarizes the measurement methods of previous studies related to management efficiency. As a result of the previous studies, total assets and total capital are used as financial input variables, number of employees as human resources input variables, and sales and net income as output variables.

Ⅲ. Methodology

3.1 Samples

The observations of this study were corporates that disclosed ESG grade by the Korea Corporate Governance Service (KCGS). KCGS has evaluated corporate governance since 2003 with the aim of supporting the improve-

ment of sustainable management of domestic listed corporates. Since 2011, it has been evaluating and disclosing ESG including the environment and society as their evaluation model that meets international standards such as OECD corporate governance principles and ISO 26000.

In this study, the observations were limited to corporate ESG disclosure by KCGS, and the observation period was set to 2019-2020 to reflect the latest trends in the ESG evaluation model. Financial data were constructed by matching KIS-VALUE of NICE based on corporate ESG disclosure. In this process, samples that did not match financial data or lacked completeness of data were excluded. In the case of financial institutions, only governance grade excluding the environment and society is disclosed, and they are excluded to maintain the homogeneity of the sample. As a result, out of 963 corporate ESG disclosure in 2019 and 1,005 corporate ESG disclosure in 2020, 767 corporates in 2019-2020 were composed of pooled, and a total of 1,534 samples were set as observations of the study.

3.2 Measurement of Management Efficiency

Stochastic Frontier Analysis (SFA) and DEA are commonly used to measure efficiency. DEA has several advantages in measuring a company's management efficiency. Unlike SFA, DEA does not need to assume specific functions and error terms to approach non-parametrically when constructing production functions (Hollingsworth et al, 1999). Therefore, the DEA may simultaneously consider numerous inputs and outputs, such as corporate management, without setting a special weight (Charnes et al, 1978). In addition, since the relative efficiency score between Decision Making Units (DMUs) is calculated, it can be used even if the connectivity between inputs and outputs is not direct without the assumption of a function (Wang & Huang, 2007). For this reason, DEA is mainly used to measure management efficiency.

DEA is divided according to the assumption of returns to scale into the CCR model (Charnes et al, 1978) of Constant Returns to Scale (CRS) and the BCC model (Banker et al, 1984) of Variable Returns to Scale (VRS). Companies operate differently depending on the size of the entity, and the criteria for evaluating efficiency are different accordingly. If it is expected to have a change in scale revenue according to the scale, it is appropriate to apply the VRS model (Chun et al, 2014). In addition, DEA is divided into input-oriented and output-oriented models according to the perspective of calculating efficiency. The input-oriented model evaluates how little input was used to produce the same output, and the output-oriented model evaluates how much output was produced with the same input. In general, the model is set based on factors that

can be controlled through decision-making in the DMU. In the case of companies, it is common to adjust inputs such as assets and the number of employees rather than outputs, so the input-oriented model is mainly used.

Therefore, in this study, the input-oriented VRS DEA model was used as a measurement model for management efficiency. Equation (1) below shows the DEA linear planning equation of the input-oriented VRS model (Fried et al, 1999).

(1)

$$L(y) = x : Yz \geq y, Xz \leq x, Iz = 1, z \in R_+^K$$

$$TE^k = \min_{(z,\lambda)} \lambda$$

$$s.t\, Yz \geq y^k,\ Xz \geq \lambda x^k,\ Iz = 1,\ z \in R_+^K$$

Here, when K is the number of DMUs, N is the number of input variables, and M is the number of output variables. The input matrix X is (N*K), the output matrix Y is (M*K), the input vector x is (N*1), and the output vector y is (M*1). z and I are weighted vectors. λ is a value that maintains an input-output ratio and proportionally reduces the input. x^k and y^k are DMU k′s output and inputs, and TE^k is DMU k′s efficiency score.

3.3 Research Model and Variables

DEA is a methodology suitable for measuring management efficiency, but there is a disadvantage in that it is not possible to consider control variables because only input and output variables are used for efficiency calculation. In other words, it is not possible to calculate an efficiency score that reflects the characteristics of a company related to output variables or efficiency. Therefore, in order to analyze the effect of specific independent variables, such as ESG, on management efficiency, it is necessary to control other characteristics using regression analysis.

In the case of the efficiency score calculated by the input-oriented DEA, the minimum value is limited from 0 to the maximum value of 1. Therefore, setting the efficiency score of the DEA as a dependent variable is not suitable for the general Ordinary Least Squares (OLS) assuming normal distribution and equal variability (Thanassoulis, 2001). For this reason, Tobit regression (Tobin, 1958), one of the censored regression models, is mainly used for regression analysis using the efficiency score of DEA (Sun et al, 2017; Yoon et al, 2022). In this study, the Tobit regression model is also used to analyze the effect of ESG on management efficiency. Equation (2) below is a censored equation of the efficiency score presented by Chilingerian(1995).

(2)

$$Management\,Efficiency\,Score_i = \begin{cases} Score_i & \text{if } score_i < 1 \\ 1 & otherwise \end{cases}$$

Based on this, the Tobit regression analysis equation used in this study is shown in Equation (3) below.

(3)

$$Score_i = \beta_0 + \beta_1 * ESG_i + \beta_2 * K200_i + \beta_3 * ESG_i * K200_i + \beta_4 * ln\_Age_i + \beta_5 * Adv\_ratio_i + \beta_6 * Cl\_ratio_i + \beta_7 * Debt\_ratio_i + Year + Industry + \epsilon_i$$

The dependent variable of the above model is management efficiency score calculated by DEA. Corporate ESG disclosure of KCGS are not limited to a specific industry. Therefore, input and output variables for measuring management efficiency are set by reflecting the general management environment based on previous studies. Accordingly, the input variables are set as total assets, total capital, and number of employees, and sales and net income are used as output variables. In the case of DEA, since the negative value cannot be processed, the entire DMU is raised so that the minimum value of net income is 1.

The ESG grade of KCGS is used as an independent variable. Among the overall ESG grades, a dummy variable of 1 for B+ or higher and 0 for less than B+ is set as an independent

〈Table 2〉 Description of variables

Variable		Description	Source
Inputs	Total assets	Total assets for the current year	KIS-VALUE
	Total capital	Total capital for the current year	KIS-VALUE
	Employees	Number of employees in the current year	KIS-VALUE
Outputs	Sales	Sales for the current year	KIS-VALUE
	Adj. Net income	The value obtained by leveling up the entire DMU so that the minimum value of net income is 1	KIS-VALUE
Independent	*ESG*	1 for the ESG grade of B+ or higher, 0 for others	KCGS
	Env	1 for the environment grade of B+ or higher, 0 for others	KCGS
	Soc	1 for the social grade of B+ or higher, 0 for others	KCGS
	Gov	1 for the governance grade of B+ or higher, 0 for others	KCGS
	K200	1 for KOSPI200 corporates, 0 for others	KRX
Control	*ln_Age*	The logarithm of (current year - established year)	KIS-VALUE
	Adv_ratio	(advertising cost / Sales) * 100	KIS-VALUE
	Cl_ratio	(current assets / current liabilities) * 100	KIS-VALUE
	Debt_ratio	(total liabilities / equity) * 100	KIS-VALUE
	Year	1 for 2020 year samples, 0 for others	-
	Industry	Dummy variables according to the major classification of Korean standard industry classification	KIS-VALUE

variable. Environmental grade, social grade, and governance grade are also used as independent variables in the same way. The size of the company, which is a moderator, is set as a dummy variable according to the presence or absence of a KOSPI200 corporate. Depending on whether or not the corporate is listed into the KOSPI200, various characteristics and firm size are different (Kwon, 1998). In addition, the activeness of corporate social responsibility differs depending on whether it is included into the KOSPI200 (Kim, 2009). For this reason, in this study, KOSPI200 is set as the proxy of firm size. The control variables are set as corporate ages, advertising cost ratio, current asset ratio, and debt ratio in consideration of the correlation between input and output variables. The year and the industrial classification are included in the control variable. The variables used in this study are summarized as follows.

Correlation analysis was performed to confirm the correlation between the variables. Table 3 shows the results of correlation analysis including ESG variables. The results of the correlation analysis showed that ESG had a negative relationship with the efficiency score within 1%. In addition, it was found that the relationship between the independent variable and the control variable was not high. These results were also the same in the correlation analysis targeting Env, Soc, and Gov variables. Although the relationship between ESG and K200 was relatively high, showing 0.5 or more within 1%, the VIF result was less than 10 in all models and variables. As a result, the problem of multicollinearity did not occur in the model of this study.

〈Table 3〉 Results of Correlation analysis

	Score	*ESG*	*K200*	*ln_Age*	*Adv_ratio*	*Cl_ratio*	*Debt_ratio*
Score	1						
ESG	-0.0862 (0.0007)	1					
K200	-0.0856 (0.0008)	0.5251 (0.0000)	1				
ln_Age	-0.0139 (0.5865)	-0.1373 (0.0000)	-0.0536 (0.0358)	1			
Adv_ratio	-0.1328 (0.0000)	0.0606 (0.0176)	0.1014 (0.0001)	-0.0458 (0.0732)	1		
Cl_ratio	0.0174 (0.4961)	-0.0622 (0.0148)	-0.0455 (0.0751)	0.0513 (0.0444)	-0.0120 (0.6393)	1	
Debt_ratio	0.1739 (0.0000)	-0.0038 (0.8812)	0.0101 (0.6931)	-0.0073 (0.7747)	-0.0785 (0.0021)	-0.0860 (0.0007)	1

Ⅳ. Results

4.1 Descriptive Statistic

Descriptive statistics were checked to find out the characteristics of the observation of this study. Table 4 shows descriptive statistics of 767 corporates from 2019-2020. In case of the total assets, which are input variables, the average was 2.3 trillion KRW. In addition, the sample was composed of relatively large companies with an average capital of 1.4 trillion KRW and 1,512 average employees, respectively. This is because most of KCGS' ESG grade measurements and disclosures targeted listed corporates. Sales, which is an output variable, averaged 1.5 trillion KRW, which also showed a large scale. However, in the case of net income, the average was 54.1 billion KRW, which was lower than other input and output variables. This may have shown low profitability depending on the characteristics of the industry because corporates from various industries were included in the study. In other words, even a large company may have low profitability.

In the case of ESG grade, an independent variable, the average is 0.3266, which means that 501 samples out of 1,534 are B+ grade

〈Table 4〉 Descriptive statistics of variables (Units: 100 millions KRW)

Variable		Mean	Std. Dev.	Min	Max
Inputs	Total assets	22,974	106,310	282	2,296,644
	Total capital	13,696	77,252	21	1,833,167
	Employees	1,512	5,558	2	109,074
Outputs	Sales	14,699	71,165	4	1,663,112
	Net income	541	6,118	-26,399	156,150
	Adj. Net income	26,939	6,118	0	182,549
Independent	*ESG*	0.3266	0.4691	0	1
	Env	0.2308	0.4215	0	1
	Soc	0.4126	0.4925	0	1
	Gov	0.5215	0.4997	0	1
	K200	0.2086	0.4064	0	1
Control	*ln_Age*	3.4316	0.7981	1	4.8122
	Adv_ratio	1.0773	2.7598	0	37.3595
	Cl_ratio	3.3097	12.1506	0.0013	317.5882
	Debt_ratio	1.0257	2.0991	0.0010	49.0825

or higher. As such, 354 samples with an average environmental grade of 0.2308, 633 samples with an average social grade of 0.4126, and 800 samples with an average governance grade of 0.5215, received a B+ grade or higher. While the governance structure and social grade were relatively high, the environmental grade was still low. In the case of variables representing the presence or absence of KOSPI200 corporates, the average was 0.2086, and 320 samples corresponded to KOSPI200 companies. In other words, 160 out of 200 KOSPI200 corporates were included in the study.

4.2 Results of Management Efficiency

The management efficiency score was calculated using DEA to construct the dependent variable of the Tobit regression model. Table 5 shows the DEA results. As a result of dividing the management efficiency scores of 1,534 DMUs by 2019 and 2020, there was no significant difference, with an average of 0.3862 and 0.3788, respectively. Looking at the frequency of appearance by score, 1.000, which represents optimal efficiency, increased from 19 in 2019 to 23 in 2020. Conversely, the number of DMUs in the 0.300-0.999 decreased from 454 in 2019 to 428 in 2020. For the number of DMUs below 0.299, it was 294 in 2019 and 316 in 2020. As a result, there was a difference in the average efficiency score and frequency of appearance in 2019 and 2020, but there was no significant difference.

4.3 Results of Tobit Regression

The Tobit regression analysis was conducted by setting the ESG grade as an independent variable and the management efficiency score as a dependent variable to find out the relationship between ESG activity and manage-

〈Table 5〉 Results of DEA

Efficiency Score	2019	2020
Mean	0.3862	0.3788
Std. Dev.	0.2036	0.2095
Min	0.0467	0.0130
Max	1.0000	1.0000
Frequency		
1.000	19	23
0.500 - 0.999	143	134
0.300 - 0.499	311	294
0.100 - 0.299	279	289
Below 0.099	15	27

ment efficiency. Table 6 shows the results of the Tobit regression analysis. Model 1 is an ESG overall grade, Model 2 is an environmental grade, Model 3 is a social grade, and Model 4 is a governance grade that acts as an independent variable. First, when looking at the coefficient of the Model 1 ESG variable, it was -0.0361, which was significant within 1% of the significance level. This means that the higher the ESG grade, the lower the management efficiency score. The Env variable of Model 2, the Soc variable of Model 3, and the Gov variable of Model 4 were also negative values as -0.0326, -0.0472, and -0.0427, respectively, and were significant within 1% of the significance level. This means that the higher the environmental, social, and governance grade, the lower the management efficiency, the same as the ESG overall grade. These results are the opposite of hypothesis 1, including hypotheses 1-1, 1-2, and 1-3.

The Tobit regression was performed using Equation (3) to analyze whether the firm size moderates the relationship between ESG activity and management efficiency. Table 7 shows a summarizing the results. As shown in Table 6, the models in Table 7 was classified according to whether ESG overall grade, environmental grade, social grade, and governance grade were used as independent variables.

〈Table 6〉 Results of Tobit regression (1)

Variable	Model 1	Model 2	Model 3	Model 4
ln_Age	-0.0004(-1.34)	-0.0003(-1.10)	-0.0004(-1.55)	-0.0004(-1.49)
Adv_ratio	-0.0097***(-5.02)	-0.0097***(-5.05)	-0.0091***(-4.72)	-0.0094***(-4.87)
Cl_ratio	0.0006(1.40)	0.0006(1.48)	0.0006(1.34)	0.0006(1.39)
Debt_ratio	0.0215***(6.60)	0.0218***(6.65)	0.0220***(6.68)	0.0213***(6.57)
Year	-0.0045(-0.44)	-0.0056(-0.54)	-0.0066(-0.64)	0.0020(0.19)
Industry	(Included)	(Included)	(Included)	(Included)
ESG	-0.0371***(-3.26)			
Env		-0.0326***(-2.61)		
Soc			-0.0472***(-4.33)	
Gov				-0.0427***(-3.90)
Cons.	0.2720***(4.17)	0.2656***(4.07)	0.2763***(4.25)	0.2968***(4.53)
Obs.	1,534	1,534	1,534	1,534
LR chi^2	157.5900	153.8000	165.6500	162.1200
Prob〉chi^2	0.0000	0.0000	0.0000	0.0000
Log likelihood	207.0245	205.1294	211.0529	209.2919
Pseudo R^2	-0.6145	-0.5997	-0.6459	-0.6322

*Note: *p〈0.1, **p〈0.05, ***p〈0.01*

First, as for ESG, environment, society, and governance grade, Model 5-8 all showed negative values within 1% of the significance level as a result of Model 1-4. This is the result of rejecting Hypothesis 1 in the model including the moderating variable. In the case of the K200 variable indicating the presence or absence of KOSPI200, the significance level was negative within 1-5% in all models. This means that KOSPI200 corporates have lower management efficiency. The larger the firm size, the larger the sales to maintain the size of the operation or to grow the size, but it may be relatively low in terms of efficiency.

Looking at the interaction term corresponding to Hypothesis 2, in Model 5, the coefficient of the ESG*K200 was 0.0787, showing significance within 5% of the significance level. This means that the larger the firm size, the more positively ESG activities control the impact on management efficiency. These results support Hypothesis 2. Looking at the

〈Table 7〉 Results of Tobit regression (2)

Variable	Model 5	Model 6	Model 7	Model 8
ln_Age	-0.0004(-1.39)	-0.0004(-1.43)	-0.0005*(-1.73)	-0.0004(-1.43)
Adv_ratio	-0.0092***(-4.76)	-0.0090***(-4.66)	-0.0089***(-4.61)	-0.0089***(-4.60)
Cl_ratio	0.0006(1.40)	0.0006(1.43)	0.0006(1.32)	0.0006(1.33)
Debt_ratio	0.0217***(6.64)	0.0215***(6.62)	0.0213***(6.54)	0.0217***(6.64)
Year	-0.0058(-0.56)	-0.0071(-0.69)	-0.0078(-0.76)	0.0002(0.02)
Industry	(Included)	(Included)	(Included)	(Included)
K200	-0.0821***(-3.08)	-0.0990***(-4.75)	-0.1121***(-3.80)	-0.0740**(-2.46)
ESG	-0.0405***(-2.72)			
*ESG*K200*	0.0787**(2.44)			
Env		-0.0642***(-3.51)		
*Env*K200*		0.1370***(4.51)		
Soc			-0.0558***(-4.28)	
*Soc*K200*			0.1172***(3.47)	
Gov				-0.0415***(-3.37)
*Gov*K200*				0.0560*(1.67)
Cons.	0.2898*** (4.44)	0.2902*** (4.47)	0.2909*** (4.49)	0.2994*** (4.58)
Obs.	1,534	1,534	1,534	1,534
LR chi^2	167.0600	179.1500	180.1100	169.5000
Prob〉chi^2	0.0000	0.0000	0.0000	0.0000
Log likelihood	211.7617	217.8055	218.2834	212.9810
Pseudo R^2	-0.6514	-0.6985	-0.7023	-0.6609

*Note: *p〈0.1, **p〈0.05, ***p〈0.01*

interaction term of Model 6-7 using environmental and social grades, the coefficients of 0.1370 and 0.1172 were significant within 1% of the significance level, respectively. This also means that the impact of ESG activities is adjusted according to the firm size, and this is the result of supporting Hypothesis 2-1 and Hypothesis 2-2. Finally, in the case of Model 8, the significance level of the interaction term was relatively low within 10%, but the coefficient was 0.0560 with a positive value and Hypothesis 2-3 was supported.

Ⅴ. Discussion and Conclusion

Today, the demand for corporate social responsibility and value is increasing. As various institutional investors consider the disclosure of ESG and sustainability management for investment, corporates are gradually focusing on ESG-related activities. In this context, this study analyzed the relationship between ESG and the management efficiency of a corporate and investigated whether the firm size moderates this relationship. The results of the empirical analysis are as follows.

First, the ESG grade had a negative effect on management efficiency. These results were the same for all models using the ESG overall, environmental, social, and governance grade, respectively. These results reject hypothesis 1 that ESG has a positive effect on management efficiency. In many previous studies, ESG activities were analyzed to have a positive effect on corporate value and financial performance. Therefore, it was predicted that it would be positive in terms of efficiency, but the negative impact of ESG was confirmed. ESG's biggest dilemma is cost, as stated in Cappucci(2018). ESG activities require a lot of cost. As such, the more social activities are carried out, the more considerable the company must invest (Kim & Park, 2021). Although ESG activities positively affect corporate value and financial performance, return to investment may be low considering these enormous costs. As a result, it would have been found that ESG had a negative effect on management efficiency. In addition, in a situation where there is insufficient financial leeway, the ESG cost of a company may become a financial burden in the short term (Jeon, 2022). A company's financial burden can negatively affect investment for business activities, which can reduce sales, and increase unnecessary debt, which can also increase the cost of debt capital. This reason also acts as a factor to reduce the management efficiency.

The second is that the effect of ESG on management efficiency is adjusted in a positive (+) direction when the firm size is large. As with the first result, the same results were obtained for all models. This result supports hypothesis 2. ESG activities require a

lot of cost and investment. Therefore, as shown in previous studies, large enterprises with many resources are more active in ESG activities (Brammer & Millington, 2006; Kim & Min, 2016; Kim, 2021). The purpose of ESG activities is to create a sustainable management environment in the long run. For this reason, the positive effect of ESG on performance may have been prominent in large enterprises that have been engaged in ESG activities for a long time and have high maturity. In addition, the larger the size of the company, the more frequently the company's activities are exposed to the market and the greater the ripple effect (Jung et al, 2012). Even in case of ESG, the larger the size of a company, the more substantial the market demand for ESG, and thus the greater the impact of ESG activities on business performance. Because of this, the impact of ESG would have been different for each firm size.

This study has two aspects of contribution. The first contribution is an academic contribution. So far, studies that reveal the effect of ESG on performance have been limited to corporate value and financial performance as a dependent variable. This study has the contribution of expanding the field of ESG research to the aspect of efficiency by using the management efficiency score through DEA. It will be possible to apply the efficiency score to the research model that has been performed on ESG. Research using various efficiency variables such as R&D efficiency and innovation efficiency as well as management efficiency as a dependent variable can be conducted. In addition, this study reveals that the effect of ESG differs according to the firm size, suggesting that corporate's characteristics should be considered in ESG research. Based on this, ESG research using various characteristics as a moderator in addition to the firm size will be possible.

The second contribution of this study is a practical contribution. Currently, ESG is receiving a lot of attention, and many companies and governments are trying to adopt ESG. However, based on the results of this study, corporate managers should be cautious about ESG activities. This does not mean that corporate should not engage in ESG activities. This means that managers need to ensure that they have sufficient resources to invest in ESG activities, and that those resources can be put to better use. For example, in case of a lack of funds, ESG activities can be postponed to a later period. In addition, instead of investing in ESG, R&D investment for market competitiveness can be prioritized, or global marketing can be conducted for market expansion. In other words, this result provides implications that managers need to adjust the speed until increasing the maturity of ESG and receiving a return when implementing ESG according to market demand. These results also have practical implications for government policy makers. Environmental re-

strictions are getting stronger in international organizations, and accordingly, the government is pushing for mandatory disclosure of ESG. In this case, policy makers can refer to the results of this study to support corporate ESG activities or consider tax benefits at the same time. It also suggests the need to reconsider the application timing and scope of the mandatory ESG disclosure by SMEs.

Despite these implications, this study has several limitations. First, the lag between ESG and corporate performance was not considered. There may be a time-lag before ESG activities affect management performance. However, in this study, only the current year's performance data were used due to the limitations of the data. If financial data are secured in the future, research considering time-lag can be conducted using it. Second, there is a limitation in generalizing the research results because the research subjects were limited to listed corporates as KCGS' ESG rating was used. In order to contribute to the discussion of the current ESG disclosure obligation for SMEs, research results targeting more diverse corporates will be needed.

References

Ahn, E. J., S. Kim, S. M. Park, and C. B. Kim (2020), "An Analysis on Operational Efficiency of Korean SMEs in Communication and Broadcasting Equipment Manufacturing Industry Using DEA Models," *Korean Corporation Management Review*, 27(3), pp. 87-108.

Amel-Zadeh, A., and G. Serafeim(2018), "Why and How Investors Use ESG Information: Evidence from a Global Survey," *Financial Analysts Journal*, 74(3), pp.87-103.

Aouadi, A., and S. Marsat(2018), "Do ESG Controversies Matter for Firm Value? Evidence from International Data," *Journal of Business Ethics*, 151, pp.1027-1047.

Auld, G., S. Bernstein, and B. Cashore(2008), "The New Corporate Social Responsibility," *Annual Review of Environment and Resources*, 33 (1), pp.413-435.

Bae, C. H., T. D. Kim, and S. C. Shin(2021), "The Trend of Studies Using Non-financial Measures in the Field of Accounting and ESG Issue," *Korean Accounting Journal*, 30(2), pp.235-276.

Banker, R. D., A. Charnes, and W. W. Cooper(1984), "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis," *Management Science*, 30(9), pp. 1078-1092.

Brammer, S. and A. Millington(2006), "Firm size, organizational visibility and corporate philanthropy: an empirical analysis," *Business Ethics: A European Review*, 15, pp.6-18.

Cappucci, M.(2018), "The ESG Integration Paradox," *Journal of Applied Corporate Finance*, 30 (2), pp.22-28.

Charnes, A., W. W. Cooper, and E. Rhodes(1978), "Measuring the Efficiency of Decision Making Units," *European Journal of Operational Research*, 2(6), pp.429-444.

Chilingerian, J. A.(1995), "Evaluating Physician Efficiency in Hospitals: A Multivariate Analysis of Best Practices," *European Journal of Operational Research*, 80(3), pp.548-574.

Chun, D. P., Y. H. Chung, and S. S. Bang(2014), "Measuring R&D Productivity of the Major Korean Firms : Using Data Envelopment Analysis," *Review of Accounting and Policy Studies*, 19(4), pp.173-190.

Fried, H. O., S. S. Schmidt, and S. Yaisawarng (1999), "Incorporating the Operating Environment Into a Nonparametric Measure of Technical Efficiency," *Journal of Productivity Analysis*, 12(3), pp.249-267.

Gillan, S. L., A. Koch, and L. T. Starks(2021), "Firms and Social Responsibility: A Review of ESG and CSR Research in Corporate Finance," *Journal of Corporate Finance*, 66, 101889.

Ha, G. R., and S. B. Choi(2018), "The Impact of Technology Innovation Activity on Managerial Efficiency: An Inverted U shaped Model," *Journal of Korean Society for Quality Management*, 46(3), pp.551-568.

Hollingsworth, B., P. J. Dawson, and N. Maniadakis (1999), "Efficiency Measurement of Health Care: A Review of Non-parametric Methods and Applications," *Health Care Management Science*, 2(3), pp.161-172.

Jeon, J. Q(2022), "Empirical Study on ESG and Investment Efficiency," *Review of Financial Information Studies*, 11(1), pp.33-52.

Jung, J. H., M. Ahn, and J. Choi(2012), "The Effect of the Marketing Expenditures on Firm Financial Performance," *Korean Business Education Review*, 27(5), pp.49-81.

Jung, M., and W. Kang(2020), "Effect of ESG Activities and Firm's Financial Characteristics," *Korean Journal of Financial Studies*, 49(5), pp.681-707.

Kim, B., and J. H. Min(2016), "An Exploratory Study on the Lead-lag Relationship between Firms' ESG Efforts and Their Financial Performance," *Journal of the Korean Production and Operations Management Society*, 27(4), pp.513-538.

Kim, C. S.(2009), "Corporate Social Responsibility and Firm Value," *Journal of the Korean Korean Journal of Financial Studies*, 38(4), pp.507-545.

Kim, D. H., and K. S. Lee(2003), "A Study on the Efficiency of Incheon International Airport's Airside using DEA," *Journal of Aviation Development of Korea*, pp.49-72.

Kim, D. Y.(2020), "A Study on the Relationship between ESG Evaluation Information and KIS Credit Ratings in Healthy Companies," *Global Business Administration Review*, 17 (3), pp.131-155.

Kim, J., S. Chung, and C. Park(2013), "Corporate Social Responsibility and Financial Performance: The impact of the MSCI ESG Ratings on Korean Firms," *Journal of the Korea Academia-Industrial Cooperation Society*, 14(11), pp. 5586-5593.

Kim, S.(2021), "Legal Issues on the Operation System of Electronic Administrative in Germany," *Distribution Law Review*, 8(2), pp.203-236.

Kim, Y., and J. Park(2021), "ESG · CSR and Corporate Financial Performance: What Have We Learned, and Where Do We Go from Here?," *Journal of Strategic Management*, 24(2), pp.75-114.

Kim, Y., J. Seok, and B. Kim(2021), "A Study on the Relationship between ESG Competency

and Firm Value: Moderating Effect of Customer's Awareness," *Korean Management Review*, 50(6), pp.1571-1593.

Kwon, T. K.(1998), "The Characteristics of the Foreign Currency Exposure of the KOSPI 200 Firms and Non - KOSPI 200 Firms - The Case of the Manufacturing Firms -," *Korean Management Review*, 27(5), pp.1311-1329.

Lee, B.(2022), "The ISSB Exposure Drafts for ESG Disclosure Standards and Tasks Ahead," *Financial Research Brief*, 31(11), pp.24-26.

Lee, M. S., and Y. Kim(2015), "An Empirical Study on the Effect of Corporate Social Responsibility Activity on Firm Value: Comparative Analysis on Integrated Index(ESG and KEJI)," *The Journal of Business Education*, 29(6), pp.345-374.

Lee, P., and Y. W. Seo(2017), "Operational Efficiency and Sales Efficiency in Korean Low-Cost Carriers," *Journal of the Korean Production and Operations Management Society*, 28(2), pp.201-220.

Leem, W. B.(2019), "Effect of Non-Financial Information on Firm Performance: Focusing on ESG Score," *Korean International Accounting Review*, 86, pp.119-144.

Li, T.-T., K. Wang, T. Sueyoshi, and D. D. Wang (2021), "ESG: Research Progress and Future Prospects," *Sustainability*, 13(21), 11663.

Lim, J. O.(2016), "Effects of Business Value of ESG Evaluation Information and Earnings Management," *Korean Business Education Review*, 31, pp.111-139.

Ma, J. H., and Y. Lee(2021), "A Study on the Efficiency Analysis of Global ICT Companies," *Korea Logistics Review*, 31(2), pp.69-79.

Min, J. H., and B. Kim(2019), "Is ESG Effort a Normative Proposition for Sustainability? An Analysis of Different Effects of Firms' ESG efforts by Their Respective Financial Status," *Korean Management Science Review*, 36, pp.17-35.

Na, Y., and S. Hong(2011), "An Empirical Analysis on Value Relevance of Corporate Social Responsibility Activities by Firm Size," *Korean Accounting Journal*, 20(5), pp.125-160.

Oh, S. H., and S. T. Lee(2019), "A Study on the Relationship between ESG Evaluation Factors and Corporate Value," *Korean Computers and Accounting Review*, 17, pp.205-223.

Park, J.(2015), "Study on the Operational Efficiency Measurement and Improvement Strategy of Agricultural Technology Centers using the Data Envelopment Analysis," *Regional Industry Review*, 38(4), pp.313-337.

Park, S., and E. Shin(2021), "Analysis of the Relationship between ESG Performance and Corporate Financial Values Focusing on SMEs," *Journal of Environmental Policy and Administration*, 29(4), pp.151-199.

Park, Y.(2017), "The Profitability of ESG Investing," *Journal of The Korean Data Analysis Society*, 19, pp.1951-1961.

Robert, K. W., T. M. Parris, and A. A. Leiserowitz (2005), "What is Sustainable Development? Goals, Indicators, Values, and Practice," *Environment: Science and Policy for Sustainable Development*, 47(3), pp.8-21.

Shin, B., S. Choi, and J. Han(2021), "Human Resource Investment in Internal Control and Operating Efficiency," *Korean Accounting Review*, 46(4), pp.1-34.

Sin, J. H.(2019), "Analysis of Financial Efficiency

of Procurement Capital and Input Assets Using Three-Dimensional DEA," *Korean Management Review*, 48(3), pp.837-851.

Son, H., and S. Yoon(2022), "Operational Efficiency Analysis of Smart Grid Industry Using Topic Modeling-DEA/Malmquist Index," *Review of Accounting and Policy Studies*, 27(1), pp.221-247.

Son, S. j.(2016), "The Relation between Financial Characteristics and Economic Performances in Korean CSR Companies : Comparative Analysis for Contextual Factors," *Korean Journal of Management Accounting Research*, 16, pp.201-240.

Sun, D., H. Ahn, T. Lievens, and W. Zeng(2017), "Evaluation of the Performance of National Health Systems in 2004-2011: an Analysis of 173 Countries," *Plos One*, 12(3), e0173346.

Thanassoulis, E.(2001), *Introduction to the theory and application of data envelopment analysis*, Springer, New York.

Tobin, J.(1958), "Estimation of Relationships for Limited Dependent Variables," *Econometrica: Journal of the Econometric Society*, pp.24-36.

Vishwanathan, P., H. van Oosterhout, and P. P. M. A. R. Heugens, P. Duran, and M. van Essen(2020), "Strategic CSR: A Concept Building Meta-Analysis," *Journal of Management Studies*, 57(2), pp.314-350.

Wang, E. C., and W. Huang(2007), "Relative Efficiency of R&D Activities: A Cross-country Study Accounting for Environmental Factors in the DEA Approach," *Research Policy*, 36(2), pp.260-273.

Woo, C., J. Kim, and S. Yoon(2021), "Cost Efficiency Analysis of Smart Mobile Companies: Focusing on Autonomous Vehicles and Drone Companies," *Korean Business Education Review*, 36, pp.227-245.

Yang, H., Y. H. Kim, and J. R. Park(2020), "The Effect of Corporate Social Responsibility on Firm Value -The Comparative Study of Korea and China -," *Journal of Industrial Economics and Business*, 33, pp.571-594.

Yi, J.(2020), "ESG Performance Evidence from Mispricing and Idiosyncratic Volatility," *Asian Review of Financial Research*, 33(3), pp.403-437.

Yoon, S., Y. Chung, and H. Son(2022), "The Relationship between Cost Behaviour and R&D Efficiency: Empirical Evidence from Korean Stock Markets," *Technology Analysis & Strategic Management*, 34(1), pp.85-98.

• The author Sangpil Yoon is a postdoctoral researcher at the Electronics and Telecommunications Research Institute. He received his Ph.D. in engineering from the School of Business and Technology Management at KAIST. His major research fields include sustainable management, management accounting, performance management, efficiency, and ESG, and he has published papers in SSCI journals such as Technovation and Science & Public Policy.

• The author Dongphil Chun is an associate professor in the Department of Management of Technology at Pukyong National University. He is an editor of Korean Business Education review and is one of the directors of Korea Technology Innovation Society and Management Accounting Association Korea. He has been interested in strategic sustainability management, managerial accounting, ESG, R&D performance management, and start-up issues with over 50 papers since 2014.