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# Article The joint effects of ESG ratings and R&D on value relevance

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# **GLOBAL BUSINESS & FINANCE REVIEW**

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# The Joint Effects of ESG Ratings and R&D on Value Relevance

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#### ABSTRACT

**Purpose:** Using the Ohlson model of value relevance (1995), we examine the incremental effects of the environmental, social, and governance (ESG) rating on accounting information regarding R&D expenditure. **Design/methodology/approach:** Samples are 3,449 firm-years of Korean manufacturing firms listed on the Korean Stock Exchange (KSE) for 2012-2021 years. We proxy the ESG activities by their ESG rating announced by the Korea Corporate Governance Service (KCGS). Our testing model is reconstructed from Ohlson's (1995) model with accounting expenses to test whether ESG rating plays an additional role in increasing the value relevance of R&D expenses. **Findings:** Results show that higher ESG ratings increase the value relevance of development costs, but not research costs. The results are robust, with alternative fixed effect or double clustering, and are more relevant to those in low-technology industries or Korean non-chaebol companies. Further analyses reveal the effects of individual ESG activities that environment (E) and governance (G) increase the value relevance of capitalized development costs, but activities related to society (S) decrease value relevance. Additional test shows that voluntary disclosure additionally increases the value relevance of in accounting information.

**Research limitations/implications:** This study shows that development cost rather than research cost increases the value relevance of companies, but ESG increases the value relevance only in terms of development cost. **Originality/value:** We firstly show the mediating role of ESG activities in increasing the value relevance of a firm through R&D expenditure separating R&D expenditure into research expense and development costs exclusively obtained from Korean public firms.

Keywords: ESG, R&D, value relevance, Ohlson model

# I. Introduction

Growing concerns about the social responsibilities of corporations mean that an increasing number of firms are releasing their sustainability reports. The need for Environmental, Social, and Governance (ESG) information is necessary to minimize the information asymmetry between managers and stakeholders and to make use of such information in firms' decisionmaking. Generally, a sustainability report is mainly composed of atypical or qualitative information to express how ESG factors affect sustainable management.

Companies voluntarily provide sustainability reports regarding their response to climate change, the activities they are undertaking to reduce carbon emissions, social investments in human resources, and issues of corporate governance. The goal of ESG is to develop socially responsible corporate values,

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balance the competing interests of economic and social values, and to allocate resources facilitating diverse interests among interested participants.

Recently, companies have been obliged to standardize their sustainability reports in order to produce reliable information, allow compatibility of released reports between firms, and ask for mandatory responsibility of ESG activities to most public firms. International Financial Reporting Standards (IFRS) Foundation has established an International Sustainability Standards Board (ISSB) and is set to announce the disclosing standards on sustainability. ISSB is a standard-setting board established in 2021-22, whose mission is to create sustainability-related financial reporting standards to respond to investors' needs for sustainability reporting.

In response to this international move, all publicly traded firms on the Korean stock market must announce their respective sustainability reports by 2030. Standardized ESG information is broadly accountable for the operating performance and market value of a public firm. Standardized information such as greenhouse gas emissions, transition risk, physical risk, climate-related opportunities, capital allocation, internal carbon price, and management compensation increase comparability among firms in the same industry and contribute to measuring additional portions of operating performance and corporate valuation, which have been excluded thus far.

Because of the difficulties in transforming the wide range of ESG activities contained in sustainability reports into quantitative data, previous studies report the effects of ESG activities using proxies of ESG scores or ratings released by external institutes (Reverte 2016; Mervelskemper and Streit 2017; Li et al. 2018; Cordazzo 2020; Irawan and Tatsuyoshi 2021). Cahan et al. (2015) report that firms with aggressive ESG behaviors and those who voluntarily disclose their ESG activities more often tend to increase their value. Li et al. (2018) show that the firms indexed to the Financial Times Security Exchange (FTSE) 300 increase their market value through voluntary ESG disclosures, which can create more robust relationships with shareholders. Mervelskemper and Streit (2017) also report that globally standardized ESG disclosures

affect corporate value more than non-standardized ESG disclosures.

The Ohlson valuation model (OVM) (1995) initiates accounting-based modeling of a firm's value (Fullana et al. 2021). Before OVM, few studies focused on how financial data are directly linked to stock prices. The OVM, which is based on the dividend discount model (DDM) and the residual income valuation model (RIM), produces firm values through a combined function of book value, accounting income, and other accounting variables. Hanson (2013) explains that corporate governance, organizational culture, and relationships with employees, customers, and business partners are all representative of non-financial information that determines future price competitiveness and profitability, and how investment in these leads to a premium on corporate values. Non-financial information incorporated with the Ohlson model (1995) can more accurately estimate a firm's value (Reverte 2016).

R&D expenditures are greatly accountable for corporate valuation as they are significantly associated with the creation of future abnormal earnings (Bublitz and Ettredge 1989; Lev and Sougiannis 1996; Abody and Lev 1998; Han and Manry 2004; Han 2006). R&D activities are not only effective in increasing corporate productivity, but they also improve business performance and reduce environmental charges for hazardous productions. In particular, R&D-intensive companies with a high ratio of R&D expenditure to overall sales are more likely to participate in corporate social responsibility (CSR) activities (Erhemjamts et al. 2013), while R&D investment in the market can catalyze the sustainable growth of a company (Yu et al. 2017; Rodrigues et al. 2020).

Previous studies show that R&D expenditure significantly increases the value relevance of companies (Lev and Zarowin 1999; Zhao 2002; Han and Manry 2004; Ahmed and Falk 2006; Han 2006). Both Han and Manry (2004) and Ahmed and Falk (2006) find that the value relevance between capitalized R&D and fully expensed R&D cost is higher than that of ordinary assets, while the value relevance of partially expensed R&D costs is similar to general assets,

indicating the differential value relevance of the capitalized and expensed R&D expenditures. Collectively, R&D activities are a tool that promotes corporate sustainability and growth potential. Thus, R&D expenditure not only increases corporate value in itself but also has a positive effect on ESG activities that indirectly increase the value relevance of a company. Since they are considered non-financial information ESG activities are expected to play a mediating role in raising the value relevance of R&D expenditure.

Using the modified OVM proposed by Han (2006) which incorporates capitalized R&D and fully expensed R&D costs, the purposes of this study are as follows. First, we test whether non-financial information such as ESG activities has an additional effect on evaluating corporate value. As mentioned, we use the modified OVM proposed by Han (2006), which incorporates capitalized R&D and fully expensed R&D costs. If ESG activities are found to create future abnormal earnings, then this modified OVM may play a mediating role in enhancing the relevance of R&D expenditure to corporate value. Second, we examine the differential effects of voluntary ESG disclosure on the value relevance of R&D expenditures. We test whether a firm that voluntarily discloses ESG activities is recognized as an activity that can generate future earnings or as an expense with no value creation.

Our findings provide evidence that firms with high ESG ratings increase the firm value more than firms with low ESG ratings. First, development costs further increase corporate value (mv) through jointly signaling effects promoted by ESG activities when the ESG rating is high. By contrast, the R&D costs of R&D do not increase a company's value through ESG ratings. Second, firms that voluntarily disclose sustainability reports increase their value more than the firms with no disclosures. Companies that voluntarily disclose sustainability reports increase the value relevance of development costs, while research costs do not affect value relevance. Third, looking at each activity of E, S, and G, environment (E) and governance (G) increase the value relevance of development cost, while society (S) decreases the value relevance. All research costs were found to be insignificant. Fourth,

after analyzing the results of the sub-sample tests, the development costs in the low-tech rather than the high-tech company, and in the non-chaebol company rather than the chaebol company, are found to increase the value relevance through the ESG rating.

## II. Literature Reviews

Increasing numbers of firms are increasing their non-financial performance efforts, which may minimize disadvantages originating from social attention on ESG regarding sustainable growth. ESG activities reflect non-financial information that does not appear in the financial statements or other officially disclosed characteristics of a firm. ESG activities represent the factors constituting firm values such as corporate governance, organizational culture, and relationships with employees, customers, and business partners. They are also important assets that determine future price competitiveness and profitability (Hanson 2013). As the financial importance of ESG is highlighted, investors use ESG ratings when considering their investment decisions in evaluating unobservable characteristics of a firm, which are essential for sustainable growth (Clementino and Perkins 2021).

Accurately estimating cash flow and risk in the market provides stakeholders with more valuable information, which can lead to higher stock prices (Wang and Li 2016). Park and Noh (2017) report that higher climate change risks decrease firm values. The disclosure of a firm's non-financial information is regarded as a positive signal that increases the value relevance of accounting information by reducing information asymmetry in the agency theory and increases the value relevance of accounting earnings in the signaling theory. Ding et al. (2018) present that corporate social performances, which reveal environment, corporate governance, employee relations and community performance, go up corporate financial performances. The EU has made non-financial information disclosure mandatory since 2014, then the disclosed information on CSR activities increase corporate value minimizing related information asymmetries among interest parties (Clementino and Perkins 2021). Reverte (2016) analyzes the relationship between CSR activities and corporate value for listed companies on Spain's IBEX 35 index from 2007 to 2011 using the Ohlson model. Their results showed that CSR activities increase the value relevance both of equity and earnings to firm values. In particular, CSR information concerning the firms in environmentally sensitive industries shows higher value relevance, for which CSR information minimizes information asymmetry by providing additional information on future environmental responsibilities such as potential lawsuits raised against particular firms.

Irawan and Tatsuyoshi (2021) show that ESG activity positively affects corporate value while at the same time suppressing overinvestment. Miralles-Quiros et al. (2018) show that the greater the ESG activity in Brazilian companies, the higher their corporate value. For each category, the activities of environment (E), governance (G) increased corporate value, and society (S) are not significant. Specifically, for the total ESG score, society (S) and governance (G) increase corporate value more in environmentally sensitive industries, indicating that those firms have more stringent environmental policies, which result in increased corporate values.

Cordazzo et al. (2020) test the value relevance of listed Italian firms before 2016 that voluntarily disclose ESG information. Italy has made ESG information disclosure mandatory since 2016. Earlier in Italy, the ownerships of public firms are not distributed enough compared with other European countries, and firms participated aggressively in CSR activities. Their results show that although ESG voluntary disclosure increases the value relevance of the asset, the mandatory disclosure itself does not affect the value relevance. This is because Italian firms are obliged to disclose minimal ESG information before 2016. ESG activity is considered the proxy for CSR and there is a body of research that analyses ESG, focusing on environmental performance and R&D intensity (Erhemjamts et al. 2013; Xu et al. 2020). Erhemjamts et al. (2013) show that R&D-intensive companies are more likely to participate in CSR activities, and their environmental performance increases as R&D expenditure increases.

Xu et al. (2020) analyze the effects of R&D expenditure and ESG activities on environmental innovation performance for listed Chinese firms from 2015-2018. They use a number of green patents and green invention patents as environmental innovation achievements and show that green innovation performance increases as the ratio of R&D expenditures to sales increases, and that green innovation performance improves as the ESG rating increases. ESG activities also show that R&D investment plays a mediating role in improving green innovation. Moreover, ESG ratings moderate the association between R&D and green innovation performance.

Previous studies show that ESG information raises the stock price of a firm by providing investors with additional information and minimizing information asymmetry. We propose the following hypothesis to verify whether a firm's ESG rating provides additional information on the firm's R&D activities to stakeholders and increases its value relevance.

**H:** The ESG rating has a greater effect on value relevance for firms with higher R&D expenses.

# III. Methods

# A. ESG Measures

We proxy the ESG activities of a firm by their ESG rating as announced by the Korea Corporate Governance Service (KCGS). ESG ratings provided by KCGS have been released since 2011 and provide various stakeholders with the ESG-related activities of all publicly traded Korean firms. ESG rating is measured in the forms of integrated and individual levels of environmental management, society, and corporate governance. Specifically, E (environment) evaluates environmental management, environmental performance, and stakeholder response, while S (society) evaluates workers, suppliers, and competitors representing the firm's socially responsible management for consumers, and local communities. Finally, G (Governance) is on the evaluation of corporate governance as shareholder rights protection, board of directors, auditing bodies, and information disclosure. We transform KCGS's ordinal grades into numeric score: excellent (S), very good (A+), excellent (A), good (B+), average (B), weak (C), and very weak (D). For this study, we transform the grades into seven numeric forms of ratings from 7 (S) to 1 (D).

#### B. Regression Model

Investors recognize sustainability reports used in corporate valuations as non-financial information that can supplement traditional accounting information (Reverte 2016). Ohlson (1995)'s value relevance model is to see how accounting information under clean surplus explain or relate to the market capitalization (mv). Equation (1) shows the clean surplus relations among accounting book values ( $BV_t$ ,  $BV_{t-1}$ ), earnings ( $X_i$ ), and dividend ( $D_i$ ), which means that book value of this year ( $BV_t$ ) is a function of book value of prior year ( $BV_{t-1}$ ), net earnings ( $X_i$ ), and dividend ( $D_i$ ) of this year (Edward and Bell 1961).

$$BV_t = BV_{t-l}, + X_t - D_t \tag{1}$$

Ohlson (1995) develop the value relevance model extending the clean surplus relation to market capitalization. Then we reconstruct Ohlson's (1995) model with numbers of accounting expenses to test whether ESG rating plays an additional role in increasing the value relevance of R&D expenses. As shown in Equation (2), the stock price (*p*) is constructed as a function of the net asset book, accounting earnings, and other information. Equation (2) also shows that the market value ( $p_t$ ) of a firm is the weighted average of the profit multiple ( $\Psi x_t$ ) and the book value of net assets ( $y_t$ ) after deducting the net dividend (*d*) plus the effect of other information

 $(v_t)$ .  $\Psi$  indicates the earnings response coefficient.

$$p_t = k(\Psi x_t - d_t) + (1 - k)y_t + av_t$$
(2)

Equation (2), which is a regression model based on Ohlson (1995), separates development cost (rnd d) from net asset book value  $(y_t)$  and is the cost deducted from sales (rnd e), advertising cost (advexp) and other general expenses (oexp). In Equation (3), the value relevance of capitalized development costs is represented by the regression coefficient of rnd d. while the value relevance of research expenses treated as expenses is represented by the regression coefficient of the variable rnd e. The coefficients of rnd d×ESG and rnd e×ESG, which are variables of interest, show the value relevance of R&D expenditures that ESG information additionally affects. We use dummy variables of ESG to form the interaction terms because the ESG ratings are originally defined in ordinal scales by the KCGS.

$$mv = \beta_0 + \beta_1 bv + \beta_2 sales + \beta_3 rnd_d + \beta_4 rnd_e + \beta_5 advexp + \beta_6 otherexp + \beta_7 bv \times ESG + \beta_8 sales \times ESG + \beta_9 rnd_d \times ESG + \beta_{10} rnd_e \times ESG + \beta_{11} advexp \times ESG + \beta_{12} otherexp \times ESG + \Sigma year fixed effects + \Sigma industry fixed effects (3)$$

where

mv	=	Market capitalization & dividend scaled by total asset:
ESG	=	Dummy variable, which takes 1 if ESG rating is greater than its median value;
bv	=	Book value scaled by total asset;
sales	=	Sales revenue scaled by total asset;
rnd_d	=	Research cost recognized as expenses scaled
		by total asset;
rnd_e	=	Development cost recognized as expenses
		scaled by total asset;
advexp	=	Advertising expenses scaled by total asset;
otherexp	=	All the other expenses excluding rnd_e,
		<i>rnd_d</i> , and <i>advexp</i> scaled by total asset;

#### C. Sample Construction

The samples of this study consist of Korean manufacturing firms listed on the Korean Stock Exchange (KSE) between 2012 and 2021. We obtain the financial data from the Fn-Guide Database and the ESG ratings data from KCGS. Table 1 shows the sampling process. We exclude 1,005 firm-years belonging to financial industries such as banking, insurance, and securities and exclude a further 2,576 samples with insufficient financial data. The final sample comprises 3,449 firm-years. Panel B of Table 1 shows the distribution of samples by year during the period 2012-2021.

# IV. Results

#### A. Descriptive Statistics

Table 2 shows the descriptive statistics for the variables used in this study. The mean value of mv is 0.592 and the median is 0.407. The mean value of *ESG* is 0.249, which is relatively low considering that the highest score is 7. The variables of interest,  $rnd_d$ , and  $rnd_e$  show mean values of 0.001 and 0.011, respectively, which are higher than the average value of  $rnd_e$ , representing a higher proportion of research cost than development cost in practice.

Table 3 shows the correlations between the variables. The correlation coefficient between mv and ESG is significant at 0.078 and has a positive (+) correlation with E, S, and G. mv has a significantly positive (+) correlation with bv, sales,  $rnd_e$ , and *advexp*, and development cost  $rnd_d$  has a negative (-), although not significant, relationship. The correlation

Table 1. Sample selection	on
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1 D C

Panel A	. Sample	e selection	process
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1 1

Sample Selection Process	N
Public firm-years for 2012-2021	7,868
(Less) Firms in financial industries	(1,005)
(Less) Firms with insufficient financial data	(2,576)
(Less) Firms without ESG scores	(838)
The final sample size used in the analyses	3,449

Panel B. Sample by year		
Year	Ν	Coverage
2012	315	9.1%
2013	337	9.8%
2014	332	9.6%
2015	340	9.9%
2016	348	10.1%
2017	361	10.5%
2018	362	10.5%
2019	350	10.1%
2020	354	10.3%
2021	350	10.1%
Total	3,449	100.0%

	min	p25	Mean	Median	p75	max	Std. Dev.
mv	.116	0.116	.592	.407	.788	4.45	.635
ESG	0	0.000	.249	0	0	1	.432
Ε	0	0.000	.293	0	1	1	.455
S	0	0.000	.3	0	1	1	.458
G	0	0.000	.303	0	1	1	.46
bv	.102	0.442	.585	.584	.747	.962	.201
sales	.036	0.527	.825	.764	1.055	2.635	.466
rnd_d	0	0.000	.001	0	0	.031	.003
rnd_e	0	0.001	.011	.004	.013	.09	.017
advexp	0	0.000	.006	.001	.004	.065	.012
otherexp	0	0.293	.668	.649	.956	2.345	.5

Table 2. Summary statistics (N=3,449)

Note: mv market capitalization & dividend scaled by total asset; *ESG* dummy variable, which takes 1 if ESG rating is greater than its median value; bv book value scaled by total asset; *sales* sales revenue scaled by total asset; *rnd\_d* research cost recognized as expenses scaled by total asset; *rnd\_e* development cost recognized as expenses scaled by total asset; *advexp* advertising expenses scaled by total asset; *otherexp* all the other expenses excluding *rnd\_e*, *rnd\_d*, and *advexp* scaled by total asset.

Variables	(1) <i>mv</i>	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(2) ESG	$0.078^{*}$ (0.000)	1.000								
(3) E	$0.035^{*}$ (0.052)	$0.658^{*}$ (0.000)	1.000							
(4) S	0.138 <sup>*</sup> (0.000)	0.751 <sup>*</sup> (0.000)	$0.524^{*}$ (0.000)	1.000						
(5) G	$0.096^{*}$ (0.000)	$0.642^{*}$ (0.000)	$0.340^{*}$ (0.000)	$0.495^{*}$ (0.000)	1.000					
(6) bv	$0.363^{*}$ (0.000)	$-0.076^{*}$ (0.000)	-0.114 <sup>*</sup> (0.000)	-0.040 <sup>*</sup> (0.028)	-0.027 (0.131)	1.000				
(7) sales	0.033 <sup>*</sup> (0.069)	-0.016 (0.368)	0.013 (0.484)	0.031 <sup>*</sup> (0.086)	0.009 (0.634)	-0.291* (0.000)	1.000			
(8) rnd_d	-0.019 (0.284)	-0.004 (0.815)	-0.004 (0.824)	-0.016 (0.368)	-0.010 (0.563)	-0.038 <sup>*</sup> (0.035)	-0.071 <sup>*</sup> (0.000)	1.000		
(9) rnd_e	$0.170^{*}$ (0.000)	0.015 (0.399)	0.010 (0.587)	$0.076^{*}$ (0.000)	-0.011 (0.557)	$0.087^{*}$ (0.000)	0.019 (0.285)	-0.020 (0.258)	1.000	
(10) advexp	$0.330^{*}$ (0.000)	$0.030^{*}$ (0.097)	-0.007 (0.683)	0.154 <sup>*</sup> (0.000)	0.043 <sup>*</sup> (0.018)	0.099 <sup>*</sup> (0.000)	0.116 <sup>*</sup> (0.000)	-0.064 <sup>*</sup> (0.000)	0.279 <sup>*</sup> (0.000)	1.000
(11) otherexp	0.012 (0.511)	-0.010 (0.577)	-0.005 (0.767)	0.046 <sup>*</sup> (0.011)	-0.014 (0.450)	-0.238 <sup>*</sup> (0.000)	$0.722^{*}$ (0.000)	-0.040 <sup>*</sup> (0.027)	0.017 (0.351)	0.180* (0.000)

Table 3. Pairwise correlations (N=3,449)

Note: mv market capitalization & dividend scaled by total asset; *ESG* dummy variable, which takes 1 if ESG rating is greater than its median value; bv book value scaled by total asset; *sales* sales revenue scaled by total asset; *rmd\_d* research cost recognized as expenses scaled by total asset; *rmd\_e* development cost recognized as expenses scaled by total asset; *advexp* advertising expenses scaled by total asset; *otherexp* all the other expenses excluding *rnd\_e*, *rnd\_d*, and *advexp* scaled by total asset. indicates that *p*-value<0.1

coefficient between *ESG* and *rnd\_d* and *rnd\_e* is not significant, and the coefficient between *S* and *rnd\_e* is significantly 0.076.

#### B. Results Analysis

#### 1. Main Results

Table 4 shows the result of the multivariate regression analyses. We check that the VIF of each variable is less than 10, with no perfect multicollinearity.

 Table 4. Regressions of ESG ratings on R&D and value relevance

	Model 1	Model 2
VARIABLES -	Depende	ent = mv
7	0.975***	0.982***
bv	(10.443)	(10.506)
	0.230****	0.205****
sales	(4.473)	(4.084)
	8.179**	2.210
rnu_u	(2.519)	(0.891)
and a	3.792**	3.633**
rnu_e	(2.455)	(2.150)
advær	15.043***	9.641***
ийчехр	(3.370)	(3.939)
otherer	$-0.079^{*}$	-0.024
oinerexp	(-1.821)	(-0.574)
by × FSG		-0.066
		(-0.619)
sales×ESG		$0.258^{*}$
		(1.860)
rnd d×ESG		43.197***
		(3.157)
rnd e×ESG		-1.811
		(-0.577)
advexp×ESG		19.219**
		(2.289)
otherexp×ESG		-0.328**
		(-2.410)
Constant	-0.287***	-0.296***
	(-3.469)	(-3.628)
Observations	3,449	3,449
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes
SE Cluster	Firm	Firm
Adj R-Squared	0.379	0.379

Note: mv market capitalization & dividend scaled by total asset; *ESG* dummy variable, which takes 1 if ESG rating is greater than its median value; bv book value scaled by total asset; *sales* sales revenue scaled by total asset; *rnd\_e* research cost recognized as expenses scaled by total asset; *rnd\_e* development cost recognized as expenses scaled by total asset; *advexp* advertising expenses scaled by total asset; *otherexp* all the other expenses excluding *rnd\_e*, *rnd\_d*, and *advexp* scaled by total asset. The values reported in parentheses are t-statistics. \*\*\*, \*\*\*, and \* indicate statistical significance at the 1%, 5%, and 10% level, respectively. Model 1 shows the results excluding ESG rating variables, and the coefficients of all variables except for other expenses show a positive, statistically significant relationship (+). The variables representing the value relevance of R&D expenses, the coefficient of  $rnd_d$  and  $rnd_e$  are 8.179 (t-statistic=2.519), and 3.792 (t-statistic=2.455), respectively, indicating that the value relevance of R&D expenditures accounted for as assets are higher than that of R&D expenditures that are treated as expenses. It is similar with the reliability of the intangible asset positively affects the value relevance of the accounting information (Ji 2018).

Model 2 shows the results of the positively mediating effects of ESG activities. The coefficient of  $rnd_d \times ESG$  is 43.197 (t-statistic=3.157), indicating that the ESG rating may increase the effect that development cost has on firm value (*mv*). By contrast, the  $rnd_e \times ESG$  is not significant, indicating that  $rnd_e$  is a current expenditure that does not contribute to the creation of future excess profits. We also execute the significance test<sup>1</sup>) to determine whether the joint effects of  $rnd_d$  and  $rnd_d \times ESG$  are statistically significant. The joint coefficient of  $(\beta_l + \beta_2) \times rnd_d$  shows 45.406 (p-value= 0.001), confirming that development cost positively increases value relevance.

Table 5 shows the results of the sensitivity tests. Panel A of Table 5 shows the empirical results of the model, which includes the alternative fixed effect. The basic model only includes the year fixed effect and the industry fixed effect. We also add the firm fixed effects to control the individual firm characteristics. However, because of the perfect multicollinearity between the industry fixed effect and firm fixed effects, we also include the year and industry fixed effects as an interaction term, as suggested by Gormley and Matsa (2014). Our results show that the coefficient of *rnd\_d×ESG* is statistically significant at 30.717 (t-statistic=2.491), representing the same tenor in Table 4. Furthermore, Panel B of Table 5 adopts an alternative model with double clustering, as shown by

<sup>1)</sup> We transform the original regression model (a) into (b), and report t-statistics of  $(\beta_1 + \beta_2)$  as follows.

<sup>(</sup>a)  $mv = \beta_0 + \beta_1 rnd_d + \beta_2 rnd_d \times ESG + \text{ controls}$ 

<sup>(</sup>b)  $mv = \beta_0 + (\beta_1 + \beta_2) \times rnd_d + \beta_2 \times (rnd_d \times ESG - rnd_d) + controls$ 

Sun et al. (2018), which proposes an advanced model of two dimensions with both firm and year. The results show the positive coefficient of  $rnd_d \times ESG$  as 43.197 (t-statistic=4.595), the same tenor as in Table 4.

These results show that development cost rather

Table 5. Sensitivity tests

Panel A: Alternative Fixed Effects

VARIABLES	Dependent = mv
rnd_d	-5.866 (-1.206)
rnd_e	-1.148 (-0.558)
rnd_d×ESG	30.717 <sup>**</sup> (2.491)
rnd_e×ESG	-0.472 (-0.306)
Constant & other controls	Yes
Observations	3,449
Year and industry fixed effect	Yes
Firm fixed effect	Yes
SE Cluster	Firm
Adj R-Squared	0.755

Panel B: Double clustering

VARIABLES	Dependent = mv
rnd_d	2.210 (1.251)
rnd_e	3.633 <sup>***</sup> (3.782)
rnd_d×ESG	43.197 <sup>***</sup> (4.595)
rnd_e×ESG	-1.811 (-1.032)
Constant & other controls	Yes
Year fixed effect	Yes
Industry fixed effect	Yes
SE Cluster	Firm & Year
Adj R-Squared	0.379

Note: *mv* market capitalization & dividend scaled by total asset; *ESG* dummy variable, which takes 1 if ESG rating is greater than its median value; *bv* book value scaled by total asset; *sales* sales revenue scaled by total asset; *md\_d* research cost recognized as expenses scaled by total asset; *rnd\_e* development cost recognized as expenses scaled by total asset; *advexp* advertising expenses scaled by total asset; *otherexp* all the other expenses excluding *rnd\_e*, *rnd\_d*, and *advexp* scaled by total asset. The values reported in parentheses are t-statistics. , , and indicate statistical significance at the 1%, 5%, and 10% level, respectively. than research cost increases the value relevance of companies, but ESG increases the value relevance only in development cost. It means that ESG is evaluated as a very important non-financial information that increase the value relevance of development costs in financial markets. However, it implies that ESG is not critical in enhancing the value relevance of research costs because expensed research costs are evaluated as limited in generating future excess profits. This suggests that both managers and stakeholders are required a new insight and evaluation of ESG activities to improve market value of R&D investments.

#### 2. Sub-sample analyses

We execute the sub-sample tests concerning the differential characteristics of industry or conglomerate governance.

Panel A of Table 6 shows the sub-sample results depending on whether or not a firm operates in a hightechnology industry. We use Francis and Schipper's (1999) method to classify industries as either highor low-tech. A firm is classified as high-tech if it is involved in either chemical and chemical product manufacturing, excluding medicines; medical substances and pharmaceutical manufacturing; electronic parts, computers, video, or audio equipment manufacturing; medical, precision, optical equipment, or watch manufacturing; electric equipment manufacturing; mail and communication; or computer programming, system integration, and management. Otherwise, the firm is classified as low-tech.

The results show that the coefficient of  $rnd_d \times ESG$ in the high-tech group is not significant, although the coefficient of  $rnd_d \times ESG$  in the low-tech group is significant at 92.368 (t-statistic=3.953). This indicates that the effects of development cost on value relevance are even more solid, which is irrelevant to the level of ESG activity. A difference test confirms that the coefficients of  $rnd_d \times ESG$  of two separate groups are significantly different, with the significant coefficient of *high-tech × rnd\_d × ESG* found to be -76.464 (p-value=0.002). The results are interpreted as a significant impact on value relevance due to external factors, such as changes in ESG levels since R&D activities have not been advanced in the case of

low-tech companies.

Panel B shows the sub-sample test results when

	Model 1	Model 2	
VARIABLES	Hitech	Non-Hitech	
-	Depend	lent = mv	
and d	2.046	1.846	
rna_a	(0.497)	(0.567)	
rnd e	3.311	3.532	
	(1.510)	(1.198)	
$rnd d \times ESG$	15.893	92.358***	
	(1.413)	(3.955)	
$rnd_e \times ESG$	-0.044 (-0.013)	-2.705 (-0.522)	
Constant & other controls	Yes	Yes	
Observations	653	2,427	
Year fixed effect	Yes	Yes	
Industry fixed effect	Yes	Yes	
SE Cluster	Firm	Firm	
Adj R-Squared	0.257	0.425	
Difference test on the coefficient of high-tech dummy×rnd_d×ESG	-76.464 (p-value=0.002)		
Panel B: Chaebol Firms or Not			
-	Model 1	Model 2	
VARIABLES	Chaebol	Non-Chaebol	
	Dependent = mv		
rnd d	9.868	0.601	
	(0.764)	(0.228)	
rnd_e	10.810	3.746	
	18.060	79 295**	
$rnd_d \times ESG$	(0.892)	(1.983)	
	-4.951	1.580	
rnd_e×ESG	(-1.330)	(0.562)	
Constant & other controls	Yes	Yes	
Observations	924	2,147	
Year fixed effect	Yes	Yes	
Industry fixed effect	Yes	Yes	
SE Cluster	Firm	Firm	
Adj R-Squared	0.588	0.355	
Difference test on the coefficient of chaebol dummy×rnd d×ESG	-60.325 (p	-value=0.056)	

Table 6. Sub-sample tests

Note: mv market capitalization & dividend scaled by total asset; *ESG* dummy variable, which takes 1 if ESG rating is greater than its median value; bv book value scaled by total asset; *sales* sales revenue scaled by total asset;  $md_d$  research cost recognized as expenses scaled by total asset;  $md_d$  advexp advertising expenses scaled by total asset; *otherexp* advertising expenses scaled by total asset; *otherexp* all the other expenses excluding  $md_d$ ,  $md_d$  advexp scaled by total asset. The values reported in parentheses are t-statistics. "\*, \*\*, and \* indicate statistical significance at the 1%, 5%, and 10% level, respectively.

a firm is classified into chaebol or non-chaebol groups. The difference test with the chaebol dummy confirms the difference is significant, indicating that the coefficient of chaebol dummy×rnd d×ESG is -60.325 (p-value= 0.056). The results implicate that a chaebol is a uniquely Korean governance form of family-oriented conglomerates. The results show that the value relevance of development costs mediated by ESG activities is relatively higher in non-chaebol groups than in chaebol groups. Compared to non-chaebol firms, Korean conglomerates such as Samsung, LG, and SK have relatively high proportions of highly profitable high-tech industries (e.g., semiconductors, smartphones, reachable batteries, EV cars, etc.). Accordingly, R&D investment is very advanced, and the impact of ESG ratings is relatively small. On the one hand, chaebol companies have a high social responsibility, so their ESG activities have already been stabilized, and the impact on R&D is small.

#### 3. Additional analyses

#### (1) Individual E, S, G rating

Table 7 shows the results of mediating effects on value relevance between the rating scores of E, S, and G and R&D expenditure. The coefficients of rnd  $d \times E$ , rnd  $d \times S$ , and rnd  $d \times G$  are 35.729 (t-statistic= 2.620), -30.855 (t-statistic=-1.955), and 26.311 (t-statistic= 2.402), respectively. By contrast, none of the values of rnd  $e \times E$ , rnd  $e \times S$ , and rnd  $e \times G$  are significant. The results show that activities in the corporate environment (E) and governance (G) increase the value relevance of capitalized development costs, but activities related to society (S) decrease value relevance. This means that directly regulated fields such as carbon emission reduction, or activities to improve governance have positive mediating effects on the corporate value of development costs. However, the activities of corporate social responsibility do not make an additional contribution increasing corporate value (Barnea et al. 2010; Aupperle et al. 2017).

Table 7. The effects of individual E, S, G ratings on R&D and value relevance

VARIABLES	Dependent = mv
hv	0.960****
	(9.712)
sales	0.185***
	(3.651)
rnd_d	0.393
	(0.130)
rnd_e	3.6/6
	6 901**
advexp	(2.294)
	0.004
otherexp	(0.101)
	-0.127
$bv \times E$	(-1.263)
	0.059
$sales \times E$	(0.924)
	35.729***
rna_a×E	(2.620)
and a × F	0.779
rna_e ^E	(0.312)
advarn×F	$10.378^{*}$
uuvexp ^ E	(1.685)
otherexn×F	-0.102*
	(-1.699)
$bv \times S$	0.051
	(0.450)
$sales \times S$	0.158
	(1.331)
rnd_d×S	-30.855
	(-1.933)
$rnd_e \times S$	1.223
	(0.321)
$advexp \times S$	(0.426)
	0.104*
otherexp  imes S	(-1.712)
	0.083
bv  imes G	(0.940)
	0.051
$sales \times G$	(0.633)
	26.311**
rna_d×G	(2.402)
$rad a \times C$	-3.145
<i>mu_e</i> ^0	(-1.458)
advern×G	10.485**
uurenp^0	(2.256)
otherern×G	-0.060
	(-0.787)
Constant	-0.280****
	(-3.382)

T <b>able 7.</b> Cont	inued
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VARIABLES	Dependent = mv
Observations	3,449
Year fixed effect	Yes
Industry fixed effect	Yes
SE Cluster	Firm
Adj R-Squared	0.383

Note: mv market capitalization & dividend scaled by total asset; ESG dummy variable, which takes 1 if ESG rating is greater than its median value; bv book value scaled by total asset; sales revenue scaled by total asset;  $md_{c}$  dresearch cost recognized as expenses scaled by total asset;  $md_{c}$  development cost recognized as expenses scaled by total asset;  $md_{c}$  development cost recognized as expenses scaled by total asset;  $md_{c}$  development cost recognized as expenses scaled by total asset;  $md_{c}$  adverp advertising expenses scaled by total asset; otherexp all the other expenses excluding  $rnd_{c}$ ,  $rnd_{c}$ , and advexp scaled by total asset. The values reported in parentheses are t-statistics. \*, \*, and \* indicate statistical significance at the 1%, 5%, and 10% level, respectively.

#### (2) Voluntary disclosure or not

According to the stakeholder theory of disclosure, markets demand that managers disclose more nonfinancial as well as financial information to improve awareness of the social role of a company and to increase the legitimacy and transparency of corporate management (Naser et al. 2006). Gao et al. (2016) state that companies require large amounts of external financing, and that the more effective their corporate governance, the greater their disclosure of CSR activities. In addition, the theory of voluntary disclosure states that companies with good ESG performance are more likely to voluntarily disclose more nonfinancial infortion as well as financial information, further increasing corporate value (Cahan et al. 2015). Cordazzo et al. (2020) report that the value relevance of companies that voluntarily disclose ESG information to listed Italian companies increased.

The sample firms with ESG ratings do not voluntarily disclose; instead, KCGS randomly selected firms from among the KSE-listed companies for their ESG scores. We additionally test whether the R&D expen-ditures of the firms that voluntarily disclose their ESG reports have more effect on value relevance. The Korean goverment does not currently oblige companies to disclose ESG activities, and so we identified firms that voluntarily disclosed information from the KRX ESG portal<sup>2)</sup> from 2019 onwards, meaning that our samples are taken from a limited time period of 2019-2021. Table 8

VARIABLES	Dependent = mv	
bv	0.983 <sup>***</sup> (6.973)	
sales	0.203 <sup>***</sup> (2.829)	
rnd_d	4.178 (0.679)	
rnd_e	4.762 <sup>*</sup> (1.757)	
advexp	3.163 (1.152)	
otherexp	-0.049 (-0.768)	
bv×ESG	-0.160 (-1.337)	
sales×ESG	0.182 (1.196)	
rnd_d×ESG	21.183 (1.212)	
rnd_e×ESG	-2.333 (-0.690)	
advexp×ESG	9.488 <sup>*</sup> (1.711)	
otherexp×ESG	-0.139 (-0.934)	
bv×ESG×voluntary	-0.253* (-1.686)	
sales×ESG×voluntary	-0.108 (-0.576)	
rnd_d×ESG×voluntary	179.369*** (3.250)	
rnd_e×ESG×voluntary	4.347 (0.999)	
advexp×ESG×voluntary	46.271*** (4.106)	
otherexp×ESG×voluntary	0.059 (0.269)	
Constant	-0.345*** (-3.338)	
Observations	1,045	
Year fixed effect	Yes	
Industry fixed effect	Yes	
SE Cluster	Firm	

Table 8. Voluntary ESG disclosure vs. others

Note: mv market capitalization & dividend scaled by total asset; ESG dummy variable, which takes 1 if ESG rating is greater than its median value; bv book value scaled by total asset; sales sales revenue scaled by total asset;  $rmd_{-}d$  research cost recognized as expenses scaled by total asset;  $rmd_{-}d$  research cost recognized as expenses scaled by total asset;  $rmd_{-}e$  development cost recognized as expenses scaled by total asset; advexp advertising expenses scaled by total asset; otherexp all the other expenses excluding  $rnd_{-}e$ ,  $rnd_{-}d$ , and advexp scaled by total asset. The values reported in parentheses are t-statistics. , and indicate statistical significance at the 1%, 5%, and 10% level, respectively.

0.311

Adj R-Squared

<sup>2)</sup> https://esg.krx.co.kr/contents/02/02020000/ESG02020000.jsp

shows whether firms that voluntarily disclose ESG activities have more effect on value relevance. The variable of voluntary is a dummy, which uses 1 for voluntary disclosure and 0 otherwise.

The coefficient of *rnd\_d×ESG×voluntary* is 179.369 (t-statistic=3.250), indicating that voluntary disclosure additionally increases the value relevance of development cost in accounting information. By contrast, the coefficient of *rnd\_e×ESG×voluntary* is not significant. Therefore, we confirm that voluntary disclosure of ESG activities has an additional effect on value relevance.

#### 4. Endogeneity check

Table 9 shows the results of controlling endogeneity using a two-stage model. Panel A shows the empirical result of the 1<sup>st</sup> staged probit model with ESG as the dependent variable, while Panel B shows the result of the analysis by including the residuals of the 1<sup>st</sup> stage as an inverse Mill's ratio in a two-step regression equation. The empirical result shows that

#### Table 9. Endogeneity check

Panel	A:	1 <sup>st</sup>	stage	of	probit	regression
1		-	Stuge	· · ·	proon	100.0001011

VARIABLES	Dependent = ESG
size	0.808*** (12.019)
roa	0.603 (1.524)
lev	0.415 (1.434)
rnd_e	7.678 <sup>*</sup> (1.750)
rnd_d	-49.147 (-1.472)
chaebol_d	0.446 <sup>**</sup> (2.573)
hitech	0.495 (0.807)
Constant	-18.119*** (-12.798)
Observations	2,879
Year fixed effect	Yes
Industry fixed effect	Yes
SE Cluster	Firm
Pseudo R-Squared	0.501

#### Table 9. Continued

Panel	B:	$2^{nd}$	stage	with	inverse	Mill's	ratio
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VARIABLES	Dependent = mv		
hu	0.982***		
DV	(12.816)		
adlaa	0.185****		
sules	(4.577)		
rnd d	5.709**		
mu_u	(1.988)		
rnd e	3.249**		
	(2.121)		
advexn	8.271****		
uurrenp	(4.282)		
otherexp	-0.035		
1	(-1.053)		
$bv \times ESG$	-0.141		
	(-1.013)		
sales×ESG	0.157		
	58 650***		
rnd_d×ESG	(4.421)		
	0 464		
rnd_e×ESG	(0.210)		
1 500	14.233***		
advexp×ESG	(2.725)		
otherern×FSC	-0.190*		
other exp ~ESG	(-1.795)		
imr	-0.035		
	(-1.629)		
Constant	-0.219****		
	(-3.027)		
Observations	2,879		
Industry fixed effect	Yes		
Year fixed effect	Yes		
SE Cluster	Firm		
Adi R-Squared	0 368		

Note: *mv* market capitalization & dividend scaled by total asset; *ESG* dummy variable, which takes 1 if ESG rating is greater than its median value; *bv* book value scaled by total asset; *sales* sales revenue scaled by total asset; *md* d research cost recognized as expenses scaled by total asset; *ind* d research cost recognized as expenses scaled by total asset; *ind* d research cost recognized as expenses scaled by total asset; *ind* d research cost recognized as expenses scaled by total asset; *ind* d research cost recognized as excluding *rnd* e, *rnd* d, and *advexp* scaled <u>by</u> total asset. The values reported in parentheses are t-statistics. , , and indicate statistical significance at the 1%, 5%, and 10% level, respectively.

the coefficient value of  $rnd\_d \times ESG$  is statistically significant, and the main results in Table 4 are still valid even after controlling the endogeneity issues.

# V. Discussion

This study makes several distinctive contributions to the literature. First, we show the mediating role of ESG activities in increasing the value relevance of a firm, through R&D expenditure. Specifically, we modify Ohlson's (1995) model in terms of expenses such as R&D, advertising, and other general expenses that are extracted from sales. Second, we divide R&D expenditure into research expense and development cost to identify its individual value relevance to overall firm value. In the Korean Accounting Standard (K-GAAP), R&D costs are classified into two stages: a research stage and a development stage (IAS 38).<sup>3)</sup> The development stage includes costs incurred by activities for investment which are expected to create future sales revenue. Korean IFRS denotes for the research costs to be fully expensed and for the development costs to be capitalized when proved economically feasible.

# VI. Conclusion

With an emphasis on CSR, social demand for ESG information is increasing because of the necessity of reducing information asymmetry between companies and stakeholders and reflecting corporate ESG activity information in important decision-making. R&D expenditures are highly accountable for corporate valuation as they are strongly related to the creation of future abnormal earnings. Both Han and Manry (2004) and Ahmed and Falk (2006) find that the value relevance between capitalized R&D and fully expensed R&D cost is higher than that of ordinary

assets, and the value relevance of partially expensed R&D costs is similar to general assets, indicating the differential value relevance of the capitalized and fully expensed R&D expenditures.

Since R&D activities promote corporate sustainability and growth potential, R&D expenditure not only increases the value relevance of a company but also has an organic relationship with ESG activities. By using the Ohlson model, this study verifies that ESG plays a role promoting the relevance of R&D expenditures to corporate value. In particular, by using a sample comprising Korean firms that separately disclose their R&D expenditure into development cost and research cost, we analyzed whether ESG activities have an additional value-added effect for each expenditure.

Our study shows that the higher the ESG rating of a company, the more the development cost increases the firm value (*mv*), whereas the research cost does not have any discernible incremental effects. In other words, the ESG rating moderates the relationship between capitalized development cost and value relevance. The results were confirmed by the sensitivity tests, which considered the alternative fixed effect, double clustering, and the 2SLS endogeneity checks. In summary, this study shows that development cost rather than research cost increases the value relevance of companies, but ESG increases the value relevance only in development cost.

Our paper has several limitations that open to future directions of study. First, ESG ratings provided by KCGS do not cover all listed firms. It may have potential bias issues. And it needs to compare the results of another proxy for ESG activity to cover potential bias problems in future study. Second, our proxy of ESG does not measure all qualitative factors because ESG ratings are not mandatory disclosed thus standardized. Third, this paper analyzes whether ESG activities, which represent non-financial information, are determinants future competitiveness and profitability, so are reflected in firm value as a premium to the book value of R&D costs with Ohlson's model (1995). It does not show the information effect of interaction between ESG and R&D activities on market responses.

<sup>3)</sup> Examples of research activities are presented in IAS 38 (Intangible Assets): (1) attain new knowledge; (2) search, evaluate, select, and apply research findings or other knowledge; (3) search for alternatives for materials, equipment, products, systems, or services; and (4) propose, design, evaluate, and select from among various alternatives for new or improved materials, equipment, products, systems, or services.

Further study is required to test the information effect of ESG on increasing value relevance of R&D costs using cumulative abnormal returns (CAR) in capital markets.

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