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The Impact of Greenhouse Gas Emissions on Corporate Social Responsibility in Korea

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Abstract: This study investigates the relationship between corporate greenhouse gas (GHG) emissions and corporate social responsibility (CSR). Using GHG emissions data and the CSR index announced by the Korea Economic Justice Institute, we find that companies emitting more GHG are highly rated in the CSR index. This relationship becomes stronger as the firm size increases. This result indicates that reducing GHG, especially for big firms, may not be an effective way to raise the firm's CSR index as expected. We interpret this result as suggesting that other social contribution behaviours may be valued more than GHG reduction, despite its actual environmental influence. We therefore argue that the current CSR index possibly underestimates the importance of environmental factors, such as GHG reduction, and thus, the index needs to be improved.

Keywords: greenhouse gas (GHG); corporate social responsibility (CSR); firm size

1. Introduction

Many countries are concerned about global warming and are working to find ways to reduce greenhouse gases (GHG) to tackle climate change. The Paris Climate Conference, concluded in 2016, reflects these concerns. Although an individual company's GHG reduction activities can shrink production and its profit, this can ultimately create external economic effects in a way that enhances the company's sustainable growth potential. Consumers will appreciate the company's efforts to grow with reduced fossil fuels or energy consumption, which can be a long-term growth engine [1]. Since environmental protection activities have been considered to be one of the important factors in assessing corporate social responsibility (CSR), it is easy to expect that GHG emissions are closely related to the social responsibility index (CSR index) rating of a firm in that the benefits of external economic effects are enjoyed by all members of the society. In principle, the CSR index needs to incorporate GHG emissions since the amount of GHG emissions is critical information for tackling climate change disaster; however, the environmental evaluation categories in Appendix A do not show clear background data, so we are not sure whether the CSR index really incorporates such invisible activities. In this study, therefore, we examine the relationship between GHG emissions and the CSR index in Korea. Our goal is twofold: the first is that we examine the relationship between the current CSR index and GHG emissions, and the second is that we try to find a way in which the CSR index can be improved.

Korea is actively participating in international efforts to tackle climate change. In November 2009, Korea announced its mid-term 30% reduction target for the business as usual (BAU) scenario by 2020, which means that the actual emissions in 2020 would be 30% lower than the baseline GHG emissions forecast in 2020. As a policy to achieve this goal, Korea introduced and operated a command-and-control GHG/energy target management system (hereinafter referred to as a "target management system") and the Emission Trading Scheme (ETS) [2]. These two policy measures cover

about 70% of the total GHG emissions and reflect the main driving forces of the Korean government's GHG reduction efforts.

Following previous successful policy experiences from EU-ETS, the Regional Greenhouse Gas Initiative, or California in the U.S., or some other regional pilot-ETSs, Korea launched the 1st national ETS within Asia in 2015. Companies are now under a strict regulation to curb emissions and should make significant reductions in GHG and fossil fuel usages. Under this situation, we can think about the proliferation of CSR usage as another way to induce the voluntary GHG reduction efforts of these companies. CSR began to be emphasized as an important consideration in corporate management in line with the social demands of the company to fulfil its social roles and responsibilities in accordance with its influence and status. In particular, as global interest in climate change grows, interest in understanding GHG reduction efforts in the CSR framework is growing. In light of these recent trends, it is necessary to examine whether the reduction efforts of regulated firms are properly reflected in the CSR index and what policy implications can be made.

Research on the effects of GHG emissions on economies and companies has mainly been conducted from the perspective of minimizing costs due to regulations such as ETS and carbon taxation. Furthermore, there have been studies from the social planner's perspective of how to set the optimal level of regulation to minimize social costs from an environmental point of view [3–7]. On the other hand, firm-level studies have focused on minimizing the cost of GHG reduction and regulatory compliance where regulations are levied [8,9]. In contrast to the importance of the economic effect of GHG reductions on the performance of firms, there are few studies on the effect of GHG reductions on the CSR. The study on a group of companies in the U.S. shows that they gain higher profits by disclosing voluntary GHG reduction efforts, even though they do not have a mandatory GHG reduction plan at the national level [10]. They show that many firms in the U.S. have set voluntary reduction targets, although the country itself has declined to ratify the Kyoto treaty to reduce GHG emissions. On the other hand, there is a study that shows that the CSR index represents a positive relationship with the ownership interests of institutional and foreign investors because the CSR can effectively incorporate the transparent information disclosures of the company [11]. The result implies that institutional investors and foreigners occupying a large share in the stock market are using the CSR index for investment decisions. Additionally, GHG emission reductions can be reflected in Tobin's q, which is investigated by [12]. They analyse the market discipline effects of shareholders and investors on GHG emission reductions and the transmission process to the firm value. Using Japanese manufacturing industry data for 2006–2008, they argue that market disciplines imposed by shareholders/investors are likely to reduce GHG emissions, resulting in corporate value improvement. It is also possible to show the effect of CSR on brand reputation and corporate profitability, as in [13]. They were the first to demonstrate that the environmental CSR has a positive impact on corporate brand reputation and corporate profitability. Likewise, the impact of the voluntary disclosure of carbon information is also analysed with Korean firm data [14]. Applying the event study methodology, the conclusion from the recent Korean firm data shows that a voluntary disclosure of carbon information has a negative effect on share prices by allowing stockholders to recognize future carbon-related costs. On the other hand, there was a study that empirically proves the effect of CSR on corporate financial performance [15]. The CSR index that they used, the KLD (Kinder, Lydenberg, Domini Research & Analytics founded in 1989 at U.S.), includes numerous dimensions, such as the community impact, corporate governance, human rights, diversity, employee relationships, environmental impact, product safety, and controversial business issues. We notice that their data set also includes non-environmental factors in the CSR index data.

Investigating a company's CSR index has been proven to be meaningful for a firm's profitability in the long-run, as shown in [13]. This publication shows that the previous studies found that the environmental CSR has a positive effect on corporate/brand reputation and corporate profitability. If the CSR increases the social reputation of a firm, consumers are more likely to express a higher loyalty for a firm with a high CSR index, which provides a long-run growth potential. Consumers

will not curtail their purchases, even if a company faces a temporary crisis, and hence, the firm can easily escape from the crisis. Although the CSR index stated in their study does not specify the environmental factor, we can interpret the result that the consumer's loyalty provides stability to the survival of the company; i.e., companies with a good reputation tend to have greater viability than others and have a high value. If GHG reduction improves the CSR rating of a firm, a firm may have voluntary incentives to decrease GHG emissions. However, GHG information disclosure can adversely affect companies in an unintended way by allowing stockholders to recognize future carbon-related costs [14]. Our study investigates whether reductions in GHG emissions are really helpful for a firm and their stockholders.

In principle, the social benefits from cutting GHG emissions by firms may spread to consumers by preventing climate change and accompanied natural disasters, and hence, companies with fewer GHG emissions should have a high CSR index. Consumers become aware of the fact that companies invest in social values and ultimately investors become aware of long-term profitability. However, the CSR is not determined solely by environmental perspectives, as shown in [15]. Since the CSR is a composite of various criteria, such as corporate stability, profitability, social contribution, and employee satisfaction, the environmental protection activities of firms can be regarded as a less important factor than the others. Some activities, such as improving the working environment of a company, are inevitably accompanied by the consumption of energy resources and fuels. Accordingly, the CSR index of a firm is not necessarily determined solely by the level of GHG emissions. If the society is not fully aware of the importance of environmental protection, in particular, it is hard to predict that companies with low GHG emissions will have a high CSR index. Therefore, it is worth analysing how a company's GHG emissions affect the formation of the CSR index.

This paper departs from previous studies in that we test whether the GHG emissions of companies are actually reflected in their CSR indexes. We have found that the effectiveness of reduction in the CSR index is not well reflected in spite of its beneficial externalities. We also find that a positive relationship between the amount of GHG emissions and CSR index becomes stronger as the size of the company increases, and that the relationship becomes weaker for small companies. This implies that, for small firms, GHG reductions may have a helpful effect on the CSR index, while other factors are more important in determining the CSR index of large firms.

The contributions of our study are as follows. First, our paper notes that, in spite of the positive external effect of GHG emission reductions, GHG reduction activities have a limitation in raising the CSR index in manufacturing-oriented countries such as Korea. Second, it is probable that Korea's CSR index underestimates the company's GHG reduction activities. This suggests that the CSR index can be improved by strengthening environmental factors.

2. Model Specification

We established a regression model to investigate the relationship between corporate GHG emissions and the CSR index. We collected the volume of GHG emissions for each firm and used it as the main proxy. To control for the firm size effect on GHG emissions, we divided a firm's GHG emissions by its sales or assets. Thus, our main independent variables for firm i are defined as follows:

$Co2tosale_{i,t}$	GHG emissions measured by tons of CO_2 during year t/Sales during year t.
$Co2toasset_{i,t}$	GHG emissions measured by tons of CO_2 during year t/Total assets at year t.

The "*Best Corporate Citizen Index*" is used as a proxy of CSR, which was announced by the Korea Economic Justice Institute [16]. The index is calculated by compiling the various social contributions of a firm. The explanation of the index is provided in Section 3. The model is as follows:

$$\begin{aligned} CSR\ index_{i,t} = \ & \beta_0 + \beta_1 Co2tosale_{i,t}(Co2toasset_{i,t}) + \beta_2 Lev_{i,t} + \beta_3 MTB_{i,t} + \beta_4 Size_{i,t} \\ & + \beta_5 ROA_{i,t} + \beta_6 Age_{i,t} + \beta_7 Tangibleshare_{i,t} + \beta_8 Salarytoasset_{i,t} \\ & + \beta_9 Ret\ Vol_{i,t} + \varepsilon_{i,t} \end{aligned}$$

β captures the relationship between each variable and the CSR index. The CSR index is not solely determined by GHG emissions. Thus, we controlled for a variety of a firm's characteristics that may have potential effects on its CSR index. Leverage (*Lev*) was included in our model as an indicator of the firm's financial soundness, since a firm with high external debts is more likely to be exposed to default risk and financial constraint. We controlled for the market-to-book ratio (*MTB*), which reflects the capital market's prospect of a firm's future performance. Previous studies include the firm size as an important determinant of CSR [17,18]. In addition, the size, market to book (book to market), and leverage of a firm have been regarded as standard characteristics of a firm in a prior study [19]. We expect large firms to have enough resources to engage in social contribution activities which may increase the CSR index. Thus, we included the firm size (*size*) in our regression model. A firm's profitability, as indicated by the return on asset (*ROA*), was included because a profitable firm may be recognized as a better one and may have slack resources to commit to CSR activities [20]. A prior study has documented the positive relationship between firm age and CSR [21]. Thus, we controlled for firm age (*Age*). The tangible asset ratio (*Tangibleshare*) was included because firms with a high tangible assets share are more likely to be traditional manufacturers. We controlled for the salary-to-assets ratio (*Salarytoasset*) because CSR may increase when a firm shares its profits with employees. Finally, the stock return volatility of a firm (*Ret Vol*) was adopted to control for the firm's uncertainty [22]. The definitions and estimation methods of each variable are presented in Table 1.

Table 1. Definitions of Key Variables.

Variables	Descriptions
$CSR\ index_{i,t}$	The CSR index compiled on annual base from Korea Economic Justice Institute;
$Co2tosale_{i,t}$	GHG emissions to sales ratio, estimated as GHG emissions volume to sales during year t;
$Co2toasset_{i,t}$	GHG emissions to assets ratio, estimated as GHG emissions volume to assets at year t;
$Lev_{i,t}$	Leverage, measured as total liability to total assets ratio at year t;
$MTB_{i,t}$	Market to book ratio, estimated as market capitalization divided by book value of equity at year t;
$Size_{i,t}$	Firm size, measured as natural logarithm of total assets at the end of year t;
$ROA_{i,t}$	Return on assets, measured as net income to total assets at year t;
$Age_{i,t}$	Firm age, estimated as the different between year t and the firm's establishment year;
$Tangibleshare_{i,t}$	Tangible assets to total assets ratio, defined as tangible assets to total assets at the end of year t;
$Salarytoasset_{i,t}$	Salary to assets ratio, defined as total salary to assets during year t;
$Ret\ Vol_{i,t}$	Return volatility, defined as standard deviation of a firm's daily stock returns during year t;

If a firm emitting less GHG is highly rated in CSR, β_1 is expected to have a significant negative sign. Conversely, if the CSR index improves with GHG emissions, β_1 may have a significant positive sign. The latter case can also occur when other social contributing activities (such as improving the labour environment or economic development) also require additional energy consumption and thus accompany GHG emissions. This positive relationship is more likely to occur in industrial countries like Korea, where heavy industries are leading economic growth.

We also examined whether the relationship between GHG emissions and the CSR index varies by firm size. Larger firms may have the ability to access various social activities other than GHG emission reductions, which are also helpful to improve the CSR index. Because of their high visibility, large firms are more likely to gain a more favourable reputation from the revealed social activities. Large firms may be easily engaged in social service with their less constrained resources. In addition, as large scale operations result in better resource allocations, large firms may initiate CSR activities with low additional costs [18]. In Korea, large firms provide a higher salary and much better working conditions, which may increase employee satisfaction. The amount of GHG emissions and the firm size may have an adverse impact on the increase or decrease in the CSR index, assuming a positive relationship between the firm size and GHG emissions. We therefore included the interaction term in the regression model and investigated the impact of the firm size.

$$CSR\ index_{i,t} = \beta_0 + \beta_1 Co2tosale_{i,t}(Co2toasset_{i,t}) + \beta_2 Co2tosale_{i,t}(Co2toasset_{i,t}) \times Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 MTB_{i,t} + \beta_5 Size_{i,t} + \beta_6 ROA_{i,t} + \beta_7 Age_{i,t} + \beta_8 Tangibleshare_{i,t} + \beta_9 Salarytoasset_{i,t} + \beta_{10} Ret\ Vol_{i,t} + \varepsilon_{i,t}$$

3. Data and Descriptive Statistics

The definition of CSR is not always consistent in different institutes and countries. For example, OECD states that "Corporate responsibility involves the search for an effective "fit" between businesses and the societies in which they operate" [23]. According to ISO 26000, social responsibility aims at the sustainable development of firms [24]. The rule says that the benefits of fulfilling CSR are "competitive advantage; reputation; the ability to attract and retain workers or members, customers, clients and users; the maintenance of employee morale, commitment and productivity; the perception of investors, owners, donors, sponsors and the financial community; relationships with companies, governments, the media, suppliers, peers, customers and the community in which it operates" [24]. Prior study has tried to clarify the concept of CSR by analyzing 37 CSR definitions and has established five dimensions of CSR (environmental, social, economic, stakeholder, and voluntariness) [25]. Following previous studies, the "*Best Corporate Citizen Index*" from the Korea Economic Justice Institute (KEJI) is adopted as the proxy of the CSR index [11,26]. KEJI has announced its top-200 corporations since 1991, which is estimated using various aspects of the firms such as soundness, social contribution, and employee satisfaction, among others. The "*Best Corporate Citizen Index*" is officially known as the KEJI index. We provide a detailed estimation factor of the KEJI index in Appendix A. (In practice, the scores evaluated for each item would be normalized and weighted averages for each firm). Because the full score of the KEJI Index changed from 75 to 100 after 2010, we adjusted the total score to 100 by multiplying the original scores for the data prior to 2010 by 1.333. However, we also checked our regression results by using the unadjusted old index and dividing our samples into two before and after the revision of the CSR index. These results were similar to our main results. The regression results estimated with the unadjusted CSR index are provided in Appendix B. We collected firm-level data from Fnguide, a financial data providing company which compiles comprehensive financial datasets and provides them to researchers and practitioners [27]. Our analysis is based on this dataset. Then, we merged these data sets with the GHG emissions volume of each firm by manually matching the values. The amount of CO_2 emissions data measured by tons of CO_2 equivalent is collected from the Greenhouse gas Inventory Research Center in Korea. The measuring methodology follows the link: Http://www.keco.or.kr/kr/business/climate/communityid/187/view.do?idx=411. As these datasets share only a small portion of firm data, the process retains 393 observations from 2007 to 2014. Production-based emissions accounting is currently preferred because of the policy aspect. GHG Emissions are calculated directly through fossil fuel use and other relevant processes according to the 2006 IPCC Guidelines for GHG reporting. In Korea, both a direct measurement of GHG emissions and indirect estimation through fuel consumption are used. It is directly measured in the case of large-scale facilities, and indirectly estimated as the emission factor of the input fuel when small-sized or when electricity is mainly used. Detailed calculation criteria shall be calculated in accordance with the methodology of the Korea Environment Corporation. The descriptive statistics for our key variables are presented in Table 2. In Table 2, the CSR index is 66.2426 at the point of 75% and 62.6790 at the point of 25%, implying that the CSR index tends to stay in a certain area. This result comes from the fact that the KEJI only announced the CSR index for the top-200 firms. For example, the highest score (1st rank) is 70.19 and the lowest score (200nd rank) is 62.02 for 2014. All continuous variables are winsorized at the highest and lowest 1% to mitigate the outlier effects.

Table 2. Descriptive statistics.

	N of Obs.	Mean	Std. Dev.	25%	50% (Median)	75%
$CSR\ index_{i,t}$	393	64.5850	2.8002	62.6790	64.2837	66.2426
$Co2tosale_{i,t}$	393	0.0392	0.0869	0.0052	0.0121	0.0408
$Co2toasset_{i,t}$	393	0.0335	0.0577	0.0044	0.0132	0.0386
$Lev_{i,t}$	393	0.4466	0.1896	0.2867	0.4294	0.5914
$MTB_{i,t}$	393	1.1664	0.8329	0.5793	0.8910	1.5565
$Size_{i,t}$	393	21.3393	1.7816	19.9490	21.0159	22.6536
$ROA_{i,t}$	393	0.0482	0.0461	0.0192	0.0443	0.0730
$Age_{i,t}$	393	3.5342	0.6450	3.5264	3.7377	3.8712
$Tangibleshare_{i,t}$	393	0.4063	0.1429	0.3050	0.3922	0.5071
$Salarytoasset_{i,t}$	393	0.0516	0.0341	0.0255	0.0421	0.0687
$Ret\ Vol_{i,t}$	393	0.0247	0.0092	0.0181	0.0229	0.0292

The table shows descriptive statistics of key variables used in regression analyses. Variables are defined in Table 1. All continuous variables are winsorized at the highest and lowest 1%.

Table 3 reports the correlation matrix among our key variables. A pairwise correlation between the GHG emissions of a firm and the CSR index represents a positive relationship, although the significance is low. This relationship is different from the common expectation that GHG reductions may enhance the CSR index. The table also shows the firm characteristics which have relationships with the CSR index. Firms with a high market-to-book ratio tend to have higher indexes. Big firms are also more likely to have higher indexes. Profitable firms with a high return on assets may have higher indexes. Firms exposed to a high return volatility have low indexes. These correlations imply that the profitability and market estimation play important roles in determining the CSR index.

The relationship of a firm's GHG emissions with other variables provides several useful implications. The significantly positive relationship between *Co2tosale* and *Age* indicates that the older the firm is, the more GHG it emits in Korea. The pairwise correlation between GHG emissions and the tangible assets share indicates that firms with many tangible facilities may emit more GHG. The relationship implies that manufacturing firms may emit more GHG than service firms. Even if the correlation matrix seems to generally support our conjecture, it needs careful interpretation because the other variables are not controlled in each of the results.

Table 3. Correlation Coefficients.

Variables	$CSR\ Index_{i,t}$	$Co2tosale_{i,t}$	$Co2toasset_{i,t}$	$Lev_{i,t}$	$MTB_{i,t}$	$Size_{i,t}$	$ROA_{i,t}$	$Age_{i,t}$	$Tangibleshare_{i,t}$	$Salarytoasset_{i,t}$
$Co2tosale_{i,t}$	0.0319									
$Co2toasset_{i,t}$	0.0158	0.9543 *								
$Lev_{i,t}$	0.0373	−0.0435	−0.0453							
$MTB_{i,t}$	0.2858 *	−0.1443 *	−0.1335 *	0.1228 *						
$Size_{i,t}$	0.3913 *	−0.0764	−0.1247 *	0.4131 *	0.1842 *					
$ROA_{i,t}$	0.1368 *	−0.0867	−0.0631	−0.3985 *	0.3585 *	0.0663				
$Age_{i,t}$	−0.1391 *	0.1160 *	0.1091 *	−0.0839	−0.2573 *	0.0267	−0.0651			
$Tangibleshare_{i,t}$	−0.0426	0.2210 *	0.2125 *	0.0928	−0.0982	−0.0993 *	−0.1784 *	−0.0084		
$Salarytoasset_{i,t}$	0.006	−0.1663 *	−0.1803 *	−0.2191 *	0.2004 *	−0.3052 *	0.0816	−0.1705 *	0.0529	
$Ret\ Vol_{i,t}$	−0.0996 *	0.0326	0.0599	0.2931 *	0.1462 *	0.0005	−0.1320 *	−0.0046	0.0388	−0.045

This table shows the pairwise correlations among the key variables. * Denotes significance at the 5% level or lower. See Table 1 for variable definitions.

4. Empirical Results

Table 4 presents the result of the regression analysis. Industry and year fixed effects are included in the model to control for industry-year specific variations of the index. The ordinary least square (OLS) standard errors may be biased in the panel data set because regression residuals may be correlated across firms and time. Thus, we estimate clustered standard errors by firm and time (two-way clustering), as suggested in prior research [28]. The result shows that the level of GHG emissions (*Co2tosale*, *Co2toasset*) is positively related to the CSR index, implying that the more GHG a company emits, the better the CSR index of the company. This result appears counterintuitive because more GHG emissions may be expected to have a negative effect on the firm's CSR index. The result shows that in Korea, a firm emitting more GHG is highly rated in terms of CSR.

Table 4. GHG emissions and the CSR index.

Dep Variable	CSR Index$_{i,t}$	CSR Index$_{i,t}$
$Co2tosale_{i,t}$	5.378 ***	
	(2.040)	
$Co2toasset_{i,t}$		8.049 **
		(3.856)
$Lev_{i,t}$	−2.583 **	−2.699 **
	(1.113)	(1.090)
$MTB_{i,t}$	0.633 *	0.636 *
	(0.347)	(0.347)
$Size_{i,t}$	0.829 ***	0.847 ***
	(0.180)	(0.184)
$ROA_{i,t}$	−2.768	−3.440
	(5.236)	(5.228)
$Age_{i,t}$	−0.112	−0.119
	(0.225)	(0.225)
$Tangibleshare_{i,t}$	−0.195	−0.093
	(1.249)	(1.265)
$Salarytoasset_{i,t}$	14.739 ***	14.007 ***
	(5.074)	(4.954)
$Ret\ Vol_{i,t}$	−36.471	−37.183
	(23.873)	(24.638)
Constant	43.777 ***	43.454 ***
	(3.288)	(3.308)
N of Obs	393	393
Adj. R-sq	0.338	0.339

This table shows the OLS regression results of the CSR index on GHG emissions. Year and industry fixed effects are included in the model, and clustered standard errors by firm and year are represented in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels for two-tailed tests, respectively. See Table 1 for the variable definitions.

Among control variables, leverage (*Lev*) is negatively associated with the CSR index, indicating that highly leveraged firms are highly rated in CSR. The significantly positive coefficient of firm size (*Size*) indicates that the CSR index is more favorable to large firms. The coefficient of salary to asset ratio (*Salarytoasset*) represents a significant positive sign, indicating that employee satisfaction may be an important determinant of a firm's CSR index. Taken together, the results in Table 4 imply that GHG reduction may not be an effective way to improve the CSR index. Instead, it implies other business activities such as salary increases may be more helpful for the CSR index. The fact that GHG reductions may not be an effective way to improve the CSR index indicates the need to improve Korea's CSR index in order to be an indicator of the effectiveness of the GHG reduction strategy at the firm level.

Table 5 shows a further analysis, including the interaction terms between GHG emissions and firm size. In this table, GHG emissions are negatively associated with the CSR index, while the interaction term shows a significant positive sign. These two results indicate that the positive relationship between

GHG emissions and the CSR index increases as the firm size grows and that a negative relationship may exist within small size firms. They suggest that micro-scale policies, such as decreasing the level of GHG emissions, may be effective in enhancing the CSR index in the case of small firms. However, it suggests that, for large firms, other social activities beyond simple environmental protections may more readily improve their CSR index. The results are consistent with our prediction that larger firms may possess various measures to increase the CSR index other than GHG emission reductions, and GHG reduction may be less affective. The signs of control variables are qualitatively similar to Table 4.

Table 5. Firm size effect on the relationship between GHG emissions and the CSR index.

Dep Variable	CSR Index$_{i,t}$	CSR Index$_{i,t}$
$Co2tosale_{i,t}$	−106.008 ***	
	(37.098)	
$Co2tosale_{i,t}$ * $Size_{i,t}$	5.268 ***	
	(1.791)	
$Co2toasset_{i,t}$		−119.186 **
		(48.576)
$Co2toasset_{i,t}$ * $Size_{i,t}$		6.064 ***
		(2.336)
$Lev_{i,t}$	−2.166 **	−2.163 **
	(1.080)	(1.044)
$MTB_{i,t}$	0.610 *	0.611*
	(0.314)	(0.322)
$Size_{i,t}$	0.592 ***	0.607 ***
	(0.143)	(0.166)
$ROA_{i,t}$	−2.188	−2.682
	(5.482)	(5.570)
$Age_{i,t}$	−0.135	−0.135
	(0.227)	(0.229)
$Tangibleshare_{i,t}$	−0.937	−0.831
	(1.190)	(1.224)
$Salarytoasset_{i,t}$	14.772 ***	14.595 ***
	(4.573)	(4.639)
$Ret\ Vol_{i,t}$	−41.923 **	−41.237 *
	(20.500)	(22.526)
Constant	49.734 ***	49.339 ***
	(2.859)	(3.226)
N of Obs	393	393
Adj. R-sq	0.367	0.362

This table shows the effect of firm size on the relationship between GHG emissions and the CSR index. Year and industry fixed effects are included in the model, and clustered standard errors by firm and year are represented in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels for two-tailed tests, respectively. See Table 1 for the variable definitions.

We additionally test whether the positive relationship varies according to firm age because the age of a firm is more likely to assess the differences between traditional manufacturers and newer service/IT industries. If the current CSR index is more favorable for old (traditional) manufacturing firms, the interaction term between firm age and GHG emissions is expected to have a significant positive sign. Table 6 represents the regression results.

Table 6. Firm age effect on the relationship between GHG emissions and the CSR index.

Dep Variable	CSR Index$_{i,t}$	CSR Index$_{i,t}$	CSR Index$_{i,t}$	CSR Index$_{i,t}$
$Co2tosale_{i,t}$	−32.281	−110.797 ***		
	(19.635)	(35.136)		
$Co2tosale_{i,t}$ * $Age_{i,t}$	9.860 *	2.104		
	(5.065)	(6.044)		
$Co2tosale_{i,t}$ * $Size_{i,t}$		5.115 **		
		(2.069)		
$Co2toasset_{i,t}$			−40.070	−139.962 ***
			(25.436)	(44.181)
$Co2toasset_{,t}$ * $Age_{i,t}$			12.772 *	7.649
			(6.784)	(6.362)
$Co2toasset_{i,t}$ * $Size_{i,t}$				5.680 **
				(2.673)
$Lev_{i,t}$	−2.687 **	−2.200 **	−2.791 **	−2.252 **
	(1.117)	(1.076)	(1.078)	(1.022)
$MTB_{i,t}$	0.728 **	0.631 **	0.725 **	0.666 **
	(0.325)	(0.309)	(0.322)	(0.310)
$Size_{i,t}$	0.809 ***	0.595 ***	0.823 ***	0.607 ***
	(0.192)	(0.143)	(0.195)	(0.163)
$ROA_{i,t}$	−2.954	−2.245	−3.573	−2.810
	(5.119)	(5.465)	(5.121)	(5.487)
$Age_{i,t}$	−0.283	−0.171	−0.374	−0.287
	(0.248)	(0.270)	(0.266)	(0.282)
$Tangibleshare_{i,t}$	−0.257	−0.928	−0.273	−0.892
	(1.243)	(1.193)	(1.263)	(1.237)
$Salarytoasset_{i,t}$	14.600 ***	14.741 ***	14.083 ***	14.603 ***
	(5.025)	(4.558)	(4.856)	(4.600)
$Ret\ Vol_{i,t}$	−40.246 *	−42.570 **	−40.166 *	−42.767 *
	(22.020)	(20.459)	(23.099)	(22.135)
Constant	45.089 ***	49.840 ***	45.214 ***	50.021 ***
	(3.871)	(2.841)	(3.733)	(3.126)
N of Obs	393	393	393	393
Adj, R-sq	0.341	0.366	0.343	0.363

This table shows the effect of firm age on the relationship between GHG emissions and the CSR index. Year and industry fixed effects are included in the model, and clustered standard errors by firm and year are represented in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels for two-tailed tests, respectively. See Table 1 for the variable definitions.

The interaction terms between firm age and GHG emissions ($Co2tosale_{i,t}$ * $Age_{i,t}$; $Co2toasset_{i,t}$ * $Age_{i,t}$) are significantly positive (p-Value < 0.10) in the first and the third columns. This implies that older companies can increase the CSR index by increasing GHG emissions. However, the significance disappears when we additionally control for the size of firms by including $Co2toasset_{,t}$ * $Size_{i,t}$, as shown in the second and the fourth columns. The result implies that the size effect includes the age effect.

5. Discussion and Conclusions

In this paper, we investigate the relationship between GHG emissions and the CSR index. A firm's CSR index is expected to be highly rated when the firm emits less GHG because the benefits of GHG reduction are enjoyed by all members of the society. However, inconsistent with common expectations, our empirical result documents a positive association between GHG emissions and the CSR index. And the positive association becomes more significant for large firms.

The results provide useful insights into the effect of GHG emissions on the CSR index. First, despite the recent tendency to focus on the environment, the effect of corporate environmental protection activities, such as GHG reduction, on the CSR index, may not be crucial. Thus, firms may have an incentive to focus on other kinds of social contribution activities to improve their CSR

index, even if the activities may not be helpful for environmental aspects. Our results imply that this tendency seems to be more prominent for large firms.

Second, the CSR index may underestimate the importance of the firm's environmental protection activities despite recent environmental concerns. Thus, the index needs to be improved in the long run by placing a heavier emphasis on environmental protections and taking into account their positive external effects.

Third, as represented in Appendix A, environmental management in the CSR index is likely to emphasize visible activities such as environmental improvement reports, environmental investment, environmental protection programs, and environment-related awards and certifications, etc. However, these activities may not be well matched to a firm's actual environmental influence, such as GHG emissions. Therefore, it is necessary to consider including actual activities such as GHG emissions or energy consumption in the CSR index.

This study has the following limitations. First, KEJI only publishes the CSR index for the top 200 firms each year, and our analysis only covers the firms included in the KEJI index. Thus, the results of different groups or industries might vary. Second, the results may only be effective in Korea, where a firm's manufacturing activity or labour environment are regarded as more important factors than environmental protection. Third, as the CSR index is designed with many factors, the effect of GHG emissions may be overwhelmed by other factors. As recommended by previous research, re-organizing the CSR index may provide useful insight regarding the underestimation problem [26]. Introducing a new index reflecting a firm's environmental activities may also be helpful. However, our research has not reached that stage yet.

Therefore, we suggest that establishing a new (sub-) index that fully incorporates a firm's GHG emissions effect would be a fruitful future research area. In addition, investigating how country-specific characteristics are related to the association between GHG emissions and the CSR may be a promising area for future study.

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Appendix A. Estimation of KEJI Index

Estimation Procedure

1. Calculate the actual value of the indicator based on the formula
2. Converts actual value by indicator to 100-point scale according to the scoring guide
3. Calculated as final score based on score weighted by indicator

Baseline Formula

$$Rating\ value = \ min\ rating + \frac{(max\ rating - min\ rating) * (actual\ value - min\ value)}{(max\ value - min\ value)}$$

Evaluation items and detailed indicators

Soundness (25 points)	Soundness of corporate governance	Portion of internal shareholdings Degree of professional manager participation Activities of outside directors Difference between ownership structure and governance structure
	Soundness of investment	Consumption expenditure R&D expenditure Facility investment
	Soundness of corporate financing	Riskiness Capital injection to affiliates Debt guarantees for affiliates
Fairness (20 points)	Fairness	Economic concentration Relationship with partner companies Observation of financial regulations Separation of financial sector and industry sector
	Transparency	Sincere disclosure of information Appropriateness of business report Audit committee management Shareholders' voting
Social contribution (15 points)	Employment equality	Share of disabled people Share of female workers Growth rate of employees Government award
	Social contribution activities	Donations Social welfare support
	Contribution to national finance	Tax payment
Consumer protection (15 points)	Protection of consumer rights	Customer satisfaction certification Customer satisfaction award Consumer complaints counseling Protection of financial consumer
	Observation of consumer law	Unfair provisions E-commerce consumer protection law violation Violation of notification obligation Compulsion of purchase Violation of laws related to visiting sales Violation of laws on the fairness of franchise business transactions Violation of laws on fair advertising
	Consumer safety	Quality and consumer safety certification
Environmental management (10 points)	Environmental improvement efforts	Environmental improvement report Energy efficiency Environmental investment Environmental protection program
	Environmental friendliness	Environment related award and certification
	Violation and contamination	Contamination of water and atmosphere, etc.
Employee satisfaction (15 points)	Workplace health and safety	Industrial accidents Workplace health and safety certifications and Awards
	Human capital development	Educational and training expenses per person Growth rate of educational and training expenses
	Wages and benefits	Wage compensation level Benefits Internal labor welfare fund Number of working years
	Labor-management relation	Labor dispute Share of temporary workers Labor-management relation improvement program

For more information, follow the link: http://ccej.or.kr/special_post/%ec%a0%9c2%ed%9a%8c-%ec%a2%8b%ec%9d%80%ec%82%ac%ed%9a%8c%ec%a0%81%ea%b8%b0%ec%97%85%ec%83%81-%eb%b0%8f-%ec%a0%9c25%ed%9a%8c-%ec%a2%8b%ec%9d%80%ea%b8%b0%ec%97%85%ec%83%81-%ec%8b%9c%ec%83%81%ec%8b%9d/.

Appendix B. Empirical Results with Unadjusted CSR Index

The KEJI index has been revised since 2010. Before 2010, the full score of the KEJI index had been 75. The old KEJI index was estimated with corporate soundness (20), fairness (11), social contribution (7), consumer protection (7), environmental management (10), employee satisfaction (10), and economic development contribution (10). The new KEJI index revised after 2010 is estimated with corporate soundness (25), fairness (20), social contribution (15), consumer protection (15), environmental management (10), and employee satisfaction (15). Thus, "economic development contribution" is dropped in the revised index and the weights of each factor are rebalanced. Thus, we re-estimated the regression model with the unadjusted CSR index and compared the results before and after the revision of the CSR index. As shown in the Table A1, the results are similar to our main results.

Table A1. GHG emissions and the unadjusted CSR index.

Dep Variable	CSR Index$_{i,t}$	CSR Index$_{i,t}$	CSR Index$_{i,t}$	CSR Index$_{i,t}$
$Co2tosale_{i,t}$	4.456 **	−100.623 ***		
	(1.824)	(33.025)		
$Co2tosale_{i,t}$ * $Size_{i,t}$		4.970 ***		
		(1.597)		
$Co2toasset_{i,t}$			6.721 **	−115.815 ***
			(3.316)	(42.201)
$Co2toasset_{i,t}$ * $Size_{i,t}$				5.840 ***
				(2.043)
$Lev_{i,t}$	−2.289 **	−1.896 **	−2.385 ***	−1.869 **
	(0.910)	(0.880)	(0.896)	(0.853)
$MTB_{i,t}$	0.504 *	0.482 *	0.506 *	0.482 *
	(0.295)	(0.263)	(0.294)	(0.269)
$Size_{i,t}$	0.711 ***	0.488 ***	0.726 ***	0.495 ***
	(0.138)	(0.097)	(0.142)	(0.115)
$ROA_{i,t}$	−1.595	−1.048	−2.157	−1.427
	(4.306)	(4.527)	(4.308)	(4.616)
$Age_{i,t}$	−0.073	−0.095	−0.079	−0.094
	(0.193)	(0.196)	(0.194)	(0.198)
$Tangibleshare_{i,t}$	0.072	−0.628	0.153	−0.558
	(1.025)	(0.941)	(1.039)	(0.981)
$Salarytoasset_{i,t}$	12.343 ***	12.374 ***	11.747 ***	12.314 ***
	(4.000)	(3.542)	(3.906)	(3.615)
$Ret\ Vol_{i,t}$	−27.686	−32.829 **	−28.281	−32.185 *
	(18.979)	(15.849)	(19.659)	(17.618)
Constant	30.731 ***	36.350 ***	30.465 ***	36.133 ***
	(2.571)	(2.025)	(2.597)	(2.325)
N of Obs	393	393	393	393
Adj. R-sq	0.951	0.954	0.951	0.954

This table shows the OLS regression results of the CSR index on GHG emissions. Year and industry fixed effects are included in the model, and clustered standard errors by firm and year are represented in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels for two-tailed tests, respectively. See Table 1 for the variable definitions.

To investigate whether the revised CSR index properly reflects the undesirable effect of GHG emissions, we divided the sample into two before and after the revision of the CSR index and re-estimated our model. The results are presented in the following Table A2.

Table A2. GHG emissions and the unadjusted CSR index before and after revision.

Dep Variable	Pre-Revision Period (2007~2010)				Post-Revision Period (2011~2014)			
	CSR Index$_{i,t}$	**CSR Index$_{i,t}$**	**CSR Index$_{i,t}$**	**CSR Index$_{i,t}$**	**CSR Index$_{i,t}$**	**CSR Index$_{i,t}$**	**CSR Index$_{i,t}$**	**CSR Index$_{i,t}$**
$Co2tosale_{i,t}$	6.836 ***	−91.450			1.742	−91.413 ***		
	(2.513)	(63.089)			(1.677)	(30.624)		
$Co2tosale_{i,t}$ * $Size_{i,t}$		4.598				4.448 ***		
		(3.008)				(1.521)		
$Co2toasset_{i,t}$			11.593 **	−90.138			2.204	−121.685 ***
			(4.798)	(78.100)			(2.784)	(40.396)
$Co2toasset_{i,t}$ * $Size_{i,t}$				4.793				5.956 ***
				(3.625)				(2.034)
$Lev_{i,t}$	−2.378 *	−2.182 **	−2.258	−1.934	−1.371	−1.010	−1.418	−0.849
	(1.296)	(1.080)	(1.373)	(1.179)	(1.397)	(1.365)	(1.404)	(1.279)
$MTB_{i,t}$	0.492	0.431	0.505	0.453	0.115	0.143	0.115	0.123
	(0.316)	(0.286)	(0.316)	(0.293)	(0.288)	(0.262)	(0.286)	(0.263)
$Size_{i,t}$	0.989 ***	0.761 ***	0.994 ***	0.785 ***	0.466 ***	0.265 ***	0.473 ***	0.237 ***
	(0.151)	(0.164)	(0.144)	(0.171)	(0.110)	(0.087)	(0.116)	(0.084)
$ROA_{i,t}$	−8.193 **	−7.535 **	−8.798 **	−8.321 **	8.567	10.046	8.301	10.920
	(3.249)	(3.579)	(3.568)	(3.789)	(7.440)	(7.115)	(7.553)	(6.995)
$Age_{i,t}$	−0.628 ***	−0.634 ***	−0.629 ***	−0.636 ***	0.032	0.003	0.030	0.005
	(0.235)	(0.208)	(0.239)	(0.215)	(0.199)	(0.212)	(0.199)	(0.215)
$Tangibleshare_{i,t}$	−1.332	−1.256	−1.324	−1.358	1.909 *	0.683	1.989 **	0.726
	(1.606)	(1.635)	(1.670)	(1.746)	(0.983)	(0.810)	(0.930)	(0.706)
$Salarytoasset_{i,t}$	21.400 ***	18.234 **	20.634 ***	18.775 **	8.585 *	10.286 **	8.347 *	10.527 **
	(6.359)	(7.017)	(6.807)	(8.063)	(4.439)	(4.366)	(4.356)	(4.358)
$Ret\ Vol_{i,t}$	−60.588	−53.836	−63.329	−59.086	−12.950	−25.661 **	−12.835	−23.694 *
	(45.107)	(43.021)	(47.319)	(45.480)	(19.055)	(12.096)	(18.805)	(12.206)
Constant	31.262 ***	35.734 ***	31.155 ***	31.868 ***	57.909 ***	62.438 ***	57.841 ***	56.203 ***
	(2.772)	(2.864)	(2.682)	(3.212)	(2.268)	(1.960)	(2.335)	(2.309)
N of Obs	183	183	183	183	210	210	210	210
Adj. R-sq	0.452	0.472	0.457	0.473	0.311	0.354	0.310	0.349

This table shows the OLS regression results of the CSR index on GHG emissions before and after revision. Year and industry fixed effects are included in the model, and clustered standard errors by firm and year are represented in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels for two-tailed tests, respectively. See Table 1 for the variable definitions.

During the pre-CSR revision period (2007–2010), the coefficient of *Co2tosale* (*Co2toasset*) is significantly positive, supporting our main argument, while the interaction terms (*Co2tosale * size* or *Co2toasset * size*) are insignificant. In the post-CSR revision period (2011–2014), the coefficient of *Co2tosale* (*Co2toasset*) becomes insignificant, but remains positive. Consistent with our main results, the interaction terms (*Co2tosale * size* or *Co2toasset * size*) remain significant. Although the results are a little different before and after revision, the signs of coefficients are still consistent with our main results in both samples. Thus, it is difficult to say that the revised CSR index reflects the undesirable social effect of GHG emissions.

References

1. Manne, A.; Mendelsohn, R.; Richels, R. MERGE: A model for evaluating regional and global effects of GHG reduction policies. *Energy Policy* **1995**, *23*, 17–34. [CrossRef]
2. Etienne, X.L.; Yu, J. Inverse price spread and illiquid trading in Korea-ETS. *Carbon Manag.* **2017**, 1–11. [CrossRef]
3. Adar, Z.; Griffin, J.M. Uncertainty and the choice of pollution control instruments. *J. Environ. Econ. Manag.* **1976**, *3*, 178–188. [CrossRef]
4. Pizer, W.A. The optimal choice of climate change policy in the presence of uncertainty. *Resour. Energy Econ.* **1999**, *21*, 255–287. [CrossRef]
5. Burtraw, D.; Palmer, K.; Kahn, D. A symmetric safety valve. *Energy Policy* **2010**, *38*, 4921–4932. [CrossRef]
6. Hoel, M.; Karp, L. Taxes and quotas for a stock pollutant with multiplicative uncertainty. *J. Public Econ.* **2001**, *82*, 91–114. [CrossRef]

7. Newell, R.G.; Pizer, W.A. Regulating stock externalities under uncertainty. *J. Environ. Econ. Manag.* **2003**, *45*, 416–432. [CrossRef]
8. Stranlund, J.K.; Moffitt, L.J. Enforcement and price controls in emissions trading. *J. Environ. Econ. Manag.* **2014**, *67*, 20–38. [CrossRef]
9. Yu, J.; Mallory, M.L. An optimal hybrid emission control system in a multiple compliance period model. *Resour. Energy Econ.* **2015**, *39*, 16–28. [CrossRef]
10. Hoffman, A.J. Climate Change Strategy: The Business Logic Behind Voluntary Greenhouse Gas Reductions. *Calif. Manag. Rev.* **2005**, *47*, 21–46. [CrossRef]
11. Oh, W.Y.; Chang, Y.K.; Martynov, A. The Effect of Ownership Structure on Corporate Social Responsibility: Empirical Evidence from Korea. *J. Bus. Ethics* **2011**, *104*, 283–297. [CrossRef]
12. Nishitani, K.; Kokubu, K. Why Does the Reduction of Greenhouse Gas Emissions Enhance Firm Value? The Case of Japanese Manufacturing Firms. *Bus. Strateg. Environ.* **2012**, *21*, 517–529. [CrossRef]
13. Khojastehpour, M.; Johns, R. The effect of environmental CSR issues on corporate/brand reputation and corporate profitability. *Eur. Bus. Rev.* **2014**, *26*, 330–339. [CrossRef]
14. Lee, S.-Y.; Park, Y.-S.; Klassen, R.D. Market Responses to Firms' Voluntary Climate Change Information Disclosure and Carbon Communication. *Corp. Soc. Responsib. Environ. Manag.* **2015**, *22*, 1–12. [CrossRef]
15. Lin, C.-S.; Chang, R.-Y.; Dang, V. An Integrated Model to Explain How Corporate Social Responsibility Affects Corporate Financial Performance. *Sustainability* **2015**, *7*, 8292–8311. [CrossRef]
16. Korea Economic Justice Institute. *17th–24th Best Corporate Citizen award Sourcebook*; Korea Economic Justice Institute: Seoul, Korea, 2008–2015.
17. Pava, M.L.; Krausz, J. The Association between Corporate Social-Responsibility and Financial Performance: The Paradox of Social Cost. *J. Bus. Ethics* **1996**, *15*, 321–357. [CrossRef]
18. Udayasankar, K. Corporate Social Responsibility and Firm Size. *J. Bus. Ethics* **2008**, *83*, 167–175. [CrossRef]
19. Jiang, G.J.; Zhu, K.X. Information Shocks and Short-Term Market Underreaction. *J. Financ. Econ.* **2017**, *124*, 43–64. [CrossRef]
20. Waddocks, A.; Graves, S.B. The Corporate Social Performance–Financial Perfprmace Link. *Strateg. Manag. J.* **1997**, *18*, 303–319.
21. Moore, G. Corporate Social and Financial Performance: An Investigation in the U.K. Supermarket Industry. *J. Bus. Ethics* **2001**, *34*, 299–315. [CrossRef]
22. Jurado, K.; Ludvigson, S.C.; Ng, S. Measuring Uncertainty. *Am. Econ. Rev.* **2015**, *105*, 1177–1216. [CrossRef]
23. The Organisation for Economic Co-operation and Development (OECD). Corporate Responsibility: Frequently Asked Questions. Available online: https://www.oecd.org/daf/inv/mne/corporateresponsibilityfrequentlyaskedquestions.htm (accessed on 27 June 2017).
24. International Organization for Standardization. *Discovering ISO 26000*; International Organization for Standardization: Geneva, Switzerland, 2014.
25. Dahlsrud, A. How corporate social responsibility is defined: an analysis of 37 definitions. *Corp. Soc. Responsib. Environ. Manag.* **2008**, *15*, 1–13. [CrossRef]
26. Cho, E.; Park, H. Is CSR Really Profitable? Evidence From Korea. *J. Appl. Bus. Res.* **2015**, *31*, 2167–2185. [CrossRef]
27. Fnguide Inc. *Dataguide*; Fnguide Inc.: Seoul, Korea, 2016.
28. Petersen, M.A. Estimating standard errors in finance panel data sets: Comparing approaches. *Rev. Financ. Stud.* **2009**, *22*, 435–480. [CrossRef]