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Non-Financial Environmental Responsibility Information, Information Environment, and Credit Ratings: Evidence from South Korea

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Abstract: The purpose of this study was to analyze which dimensions of non-financial environmental responsibility information are more reflected in credit ratings. The non-financial environmental responsibility information used in this study was environmental strategy, environmental organization, environmental management, environmental performance, and stakeholder communication. Based on 1085 companies listed on the Korean capital market from 2013 to 2018, this study reports that the more companies engage in environmental responsibility activities, the better their credit ratings are. Specifically, it found that companies with higher environmental performance and stakeholder communication activities received better credit ratings, while higher environmental management and environmental strategy scores had a relatively weak influence. This indicates that among the corporate environmental responsibilities, the more activities requiring relatively little discretion from managers are performed, the more the reputation capital that is accumulated through corporate environmental responsibility (*CER*) activities, which leads to higher credit ratings. These associations were found to be strengthened in an information environment where there is a higher degree of information asymmetry and the lifecycle of a firm is at a maturity stage.

Keywords: non-financial environmental responsibility information; information asymmetry; corporate lifecycle; credit ratings

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Citation: Yoo, Y. Non-Financial Environmental Responsibility Information, Information Environment, and Credit Ratings: Evidence from South Korea. *Sustainability* **2021**, *13*, 1315. https://doi.org/10.3390/su13031315

Academic Editors: Radim Cajka, Trần Minh Tùng and Jiri Brozovsky
Received: 26 December 2020
Accepted: 21 January 2021
Published: 27 January 2021

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1. Introduction

Investors' interest in environment, social, and governance (ESG) investing is booming. This trend is also called "impact investing", which indicates investments made into corporations, organizations, and financial funds with the intent of creating a measurable, beneficial social or environmental influence combined with financial performance (the definition in Wikipedia). Impact investors invest their resources to raise social and environmental topics. For example, they actively allocate their capital in businesses, non-profit organizations, and funds in industries such as renewable energy, biotech firms, and eco-friendly service companies including housing, healthcare, and sustainable agriculture. Especially, G20 nations have been shifting trillions into impact investing, green infrastructure, and inclusive growth, and institutional investors such as North American and European development finance institutions and pension funds have taken a primary position in the improvement of impact investing [1]. Even the Catholic church has become an impact investor [2]. Likewise, impact investing arises across financial asset classes including private equity/venture capital, liability, and fixed income and can be conducted in either emerging markets or developed countries.

The extensive social momentum for ESG investments and the continuing search for value-added returns has put pressure on financial institutions to involve ESG strategies in their portfolios. These trends in ESG investments have also fascinated academics [3–5]. There are two opposing views about ESG investment: the shareholder theory against it and the stakeholder theory in favor of it. First, according to the shareholder theory, the top priority of a company is to maximize its value [6]. Some researchers in favor of the

shareholder theory claim that ESG investment consumes scarce resources in companies that should be allocated to creating income. In this regard, there will be a negative relationship between ESG investment and shareholder value maximization. On the contrary, Freeman (1984)'s stakeholder theory argues that companies should go beyond the interests of shareholders and pay attention to the benefits of other stakeholders [7]. In addition, Jones (1995) expanded the stakeholder theory by asserting that ESG investment is a key factor in securing essential resources for corporate survival and financial support from stakeholders [8].

A survey from an accounting firm (KPMG) reports that the most remarkable reason for investing in ESG is the fact that responsibility investment delivers potential economic performance in equity markets caused by an optimistic reputation effect [9]. Moreover, the growing attention paid to ESG investments has also led to an increase in the debt market's awareness of reputational risk regarding the default risk of borrowing firms. These risks indicate that lenders have incentives to incorporate non-financial ESG information into the creditworthiness assessment of borrowing firms. These tendencies have been increasing since global lenders signed the United Nations Environment Program's Statement by Banks on the Environment and Sustainable Development [10]. Thompson and Cowton (2004) showed that 60% of UK banks had incorporated ESG investment in their lending policies [11]. Moreover, the growing social awareness of ESG practices also offers them an opportunity to emphasize their ESG stances central to their activities or brands for lenders [11,12]. For instance, the UK Co-operative Bank has denied loans to borrowing firms due to concerns with ESG investments [13]. Zeidan et al. (2015) also found that since ESG information could signal a long-term presence with its contribution to the environment and society, banks incorporate ESG practices in credit assessment processes [14]. Overall, ESG information is internalized in lending businesses by containing it in their primary checklists for risk assessment and responsible management.

Practically, ESG information can be highly significant to lenders if they certainly signify risk factors that are not uncovered by existing measures of financial health. However, despite the international recognition of corporate ESG practices, recent studies on their impact on the cost of capital are still controversial. Empirical results in equity markets document that U.S. firms with high-quality ESG investments achieve lower costs for equity financing [15]. Though there are predominant empirical findings showing a positive relationship between ESG investment and equity market performance, there is still a lack of consistent results in the debt market. On the one hand, prior studies have found a negative association between ESG investment and the cost of debt capital [16–19]. On the other hand, some papers report a positive or insignificant relationship between ESG investment and debt financing costs [20–22]. These vague, inconclusive, and inconsistent results motivated a study to investigate the economic consequences of ESG investment for credit ratings in South Korea.

Specifically, this study examined the association between non-financial environmental responsibility information and credit ratings in the Korean bond market. The reason why I focused on corporate environmental responsibility (*CER*) is that among the three different ESG factors, environmental issues such as ecological pollution and imbalances, and resource exhaustion have direct and negative externalities on society, which leads to regulatory action. Additionally, environmental problems are increasingly becoming international and political issues that harm human survival and corporate sustainability. Moreover, this study is the first to attempt to investigate the effect of non-financial environmental responsibility information on credit ratings by using sub-dimensions that have not been analyzed yet in South Korea. I employed *CER* score data provided by the Korea Corporate Governance Service (KCGS). The KCGS is a semi-governmental institute that evaluates various features of the sustainability management of Korean firms. Since the *CER* score consists of five dimensions (corporate environmental strategy, organization, management, performance, and the communication of environmental information to the stakeholders), the advantage of this study is that it could analyze which factors had the greatest influence

on credit ratings. Prior studies based on the risk management view state that the effects of ESG investments appear as a form of moral capital or intangible assets [23]. Since credit ratings incorporate financial and non-financial data in their valuations, *CER* information, which signals a corporate's eco-friendly dedication while decreasing information asymmetry, even if it shows higher costs incurred by the *CER* activities, can reduce financing costs due to the lower perceived reputational risks as assessed through the credit rating measure. Among the five *CER* dimensions, this study expected that the factor of high discretion of the manager would have a relatively weak influence on the credit rating, and the more objective *CER* dimensions would increase the credit rating.

In a sample of 1085 firm-year observations, this study documents that non-financial environmental responsibility information plays a significant role in reducing credit risk, thereby increasing credit ratings. These results indicate that the degree to which firm-specific non-financial environmental information is reflected in credit ratings in a proper manner is significantly greater for firms with good corporate environmental strategies, organization, management, performance and communication of environmental information to stakeholders. In addition, the subsample analyses showed that the positive relationship between *CER* dimensions and credit ratings is more pronounced in more highly information-asymmetric firms and firms with mature R&D states. These empirical results are robust to the use of firm clustering analyses to address endogeneity problems.

This paper is organized as follows: following the introduction in Section I, Section II discusses the theoretical background of the paper and describes the hypotheses, Section III is the stages of the research design and the sampling process, Section IV states the empirical results of the study, and Section V is the conclusions, which completes the study by mentioning its results and contributions.

2. Literature and Hypothesis Development

2.1. Institutional Background

The United Nations Global Compact, UNGC, showed through research that among the countries in the world, 88% of the CEOs from more than 100 countries believe that the broad integration of the issues of sustainable management in the financial market is an essential factor for the advancement of successful management [24]. The social interest in sustainable management has also increased in South Korea. In 2003, there were only three firms that had published an Environmental, Social, and Governance (ESG) activity report, namely, a sustainable management report for the first time, whereas in 2018, 135 firms and public institutions had presented such reports [25]. Likewise, Socially Responsible Investments (SRIs) by institutional investors have continually been made, especially since the UN Principles for Responsible Investment (PRI) were reported in 2006, and the domestic asset management companies signed a related agreement in a SRI (Socially Responsible Investment) international conference (2787 institutions in 2019). The key of the UN PRI is that investing firms will consider ESG information including the target firm's environmental, social, and governance elements when deciding on investment. In 2009, the National Pension Service was the first among the domestic pension fund investment agencies in applying the UN PRI, and seven fund investment agencies applied them at the end of 2019. Especially from 2015, the National Pension Service started considering social responsibilities such as the ESG of firms when making investment decisions. As they have disclosed such ways of fund management and operation, the National Pension Service, which is the largest domestic investor, has embarked upon a step of promoting and encouraging the ESG investment of firms.

As the social perception of sustainable management and SRI is widening, to reduce the information asymmetry between firms and investors, investors are requiring financial information and non-financial information including ESG information. The response has been fast; the number of firms that are voluntarily disclosing sustainable management reports to the capital market and investors, considering their contributions in ESG activities and Corporate Social Responsibility (CSR) activities, is continually increasing. Such sustainable

management reports are written based on the GRI (Global Reporting Initiative) standard and ISO26000 international standard and are voluntarily disclosed after they receive certification by outside advisory bodies. In Korea, a member of the national assembly proposed, in 2013, legislation for disclosing non-financial information, a "partially revised legislation of the capital market and financial investment industry" that requires firms to disclose their Corporate Social Responsibility (CSR) information, including environmental and human rights issues, and plans to eradicate corruption, by requiring them to be recorded in the listed firms' management reports. There are also efforts proceeding to make mandatory the disclosure of the firms' information on sustainable management.

On the other hand, as the importance of the non-financial information of Environmental, Social, and Governance information is increasing, in order to evaluate the level of sustainable management of domestic firms, government-related institutions and private institutions have been analyzing, consulting, and evaluating ESG factors, mainly since the 2000s. The Korea Corporate Governance Service (KCGS) has not only evaluated governance from 2003 but has also added environmental and social responsibility, according to the investment proliferation of ESG. From 2011, it developed the principles of OECD governance and ESG assessment models fitting international standards such as ISO26000. Thus, it has been evaluating the ESG levels of all listed firms and has been reporting their overall levels and levels for each area, according to four levels. In detail, Environment (E) consists of environmental organization, environmental management, environmental performance, and responses to stakeholders. Social (S) consists of responding to laborers, cooperative and competing firms, consumers, and the local society. Governance (G) consists of evaluating the protection of shareholders' rights, the board, the auditing body, and disclosure. This study used levels from the environment (E) for verification analysis.

The KCGS is providing the detailed assessment model, detailed items, and result reports only to assessment-targeted firms. A summary of the assessment model for the environmental area disclosed by the KCGS is shown in Table 1. The basic assessment consists of 13 large categories and 237 core assessment items, while the intensive assessment consists of 40 core assessment items (increased from 38 to 40 items in 2018). The assessment level that is finally disclosed consists of seven levels, from Level S to Level D, which appear in Table 2.

2.2. Prior Research on Credit Ratings

The credit rating is a system that evaluates and discloses the overall level of the ability to repay principal and interest by comprehensively analyzing not only the financial data of the firm issuing the bonds but also its non-financial data, serial relationships, and the characteristics of the industry the firm belongs to. The individual/objective credit rating provided by credit rating results adjusts the problem of information asymmetry in the capital market and improves the effectiveness of the capital market through the effective distribution of scarce resources. Thus, the credit rating system's main purpose is to measure from various angles and transfer information on the level of risk in the repayment of principal and interest that could occur for the investor. Furthermore, from the firm's point of view, by applying interest rates differently, it can obtain secure long-term funding for minimal capital procurement costs. Therefore, firms that intend to issue corporate bonds make various efforts to receive better credit ratings.

There are three firms, Korea Ratings Inc., NICE Ratings Inc., and Korea Investors Service Inc., that are credit rating firms in Korea. They disclose the rating methods for each industry on their homepages every year [26]. The targets of analysis according to the investigation of each rating firm's rating method are summarized in Table 3.

Table 1. Key assessment items for the environmental area.

Environmental Management	I. Environmental Strategy	a. The will of the CEO
		b. Environmental strategy and policy
	II. Environmental Organization	a. Culture of environmental structure
		b. Environmental structure system
	III. Environmental Management	a. Setting the goal and plan
		b. Eco-friendly supply chain management
		c. Clean production system
		d. Environmental risk management
		e. Environmental accounting
		f. Environmental performance management
		g. Environmental audit
	IV. Environmental Performance	a. Resource
		b. Climate change
		c. Environmental laws and regulations
		d. Eco-friendly products and services
	V. Responses to Stakeholders	a. Environmental report
		b. Response activities for stakeholders
		c. Post-processing activities for environmental laws
		d. Conflict occurrence from civil complaints based on environmental issues

Source: Korea Corporate Governance Service (KCGS).

Table 2. Distribution status of Level E in 2019.

Level E	S	A+	A	B+	B, C, D	Total
Year 2019 Number of firms (%)	0 firms	5 firms (0.7%)	36 firms (4.8%)	90 firms (12.1%)	615 firms (82.4%)	746 firms (100%)

Source: Amended citation from Korea Corporate Governance Service website (www.cgs.or.kr), 2019.

Table 3. Credit rating items.

Target of Analysis	Detailed Item
Industry Environment	Analysis of general characteristics of the industry, internal structure, and competition factors.
Management Environment	Management policies and corporate governance. Policy efficiency and human resource level.
	Status of affiliated relationships, interdependence of affiliated firms.
Business Competitiveness	Market position, competitiveness, and market share.
Profitability and Financial Structure	Growth potential, profitability, financial policy, and corporate governance.

As shown above, the relevant firm's management policy, corporate governance, policy efficiency, and human resource level are detailed items that are considered in management environment analysis. ESG information is expected to be considered as a detailed item of the management environment.

Verrecchia (1983) reported that there was intent to reduce the procurement costs of firm's external funds by mitigating the information asymmetry of the firms [25–27]. Bushman and Smith (2001) also stated that disclosure that eases information asymmetry could improve the firm's capability for investing in investment alternatives with profitability [28]. Therefore, *CER* information mitigates reputation risk and information asymmetry, enabling the firm to receive high credit ratings.

2.3. Hypothesis Development

To date, it has been hard to find studies on the significance of non-financial environmental information to debt markets. From the shareholder theory view, maximizing the firm's value is the top priority for corporations. Therefore, investment in *CER*-related activity is regarded as a wasteful expenditure of stockholders' cash, and this tendency is not recommended in the pursuit of value maximization for shareholders [6]. Thus, shareholder theory can be summarized as the idea that *CER* activities prohibit the efficient allocation of corporate resources that could provide incremental benefits for shareholders; therefore, higher *CER* activities could exploit shareholders' interests. Especially, paying high costs is related to decreased income, meaning that interest-paying ability is reduced, both of which can be related to higher costs of debt financing due to increased distress risks.

Meanwhile, according to the shareholder theory represented by Freeman (1984), rather than representing the interests of shareholders, which are internal stakeholders, companies should also take care of the interests of external stakeholders, the main source of corporate financing [7]. Jones (1995) extends this theory by arguing that CSR-related activity is crucial for companies to be able to earn necessary capital and to drive support from external stakeholders [8].

From the perspective of stakeholder theory, *CER* activities can decrease the cost of capital for the following reasons. First, *CER* activities can create invisible assets such as reputation capital, as these activities signal corporate dedication to engaging in responsible investment, which in turn leads to long-term shareholder benefits. Since environmental problems including air and water pollution and climate change are dangerous and long term compared to social or governance risks that are absorbed internally, and their ripple effects are directly transmitted to outside investors, *CER*-based reputation capital could eventually influence the cost of capital. Second, prior studies have found that value-relevant information can reduce adverse selection and moral hazard problems in the capital market by mitigating information asymmetries between insiders and outsiders [29]. If *CER* activities create transparent information, they decrease the environmental risk and information asymmetry, and contribute to lower costs of capital [8,30,31]. For example, eco-friendly firms may perceive relatively lower litigation risk compared to irresponsible firms. Litigation risk indicates the possibility of facing litigation due to environmental problems such as environmental pollution and harmful products. This type of litigation risk worsens the short-term profitability of the firm and, as a result, negatively affects the long-term cash flow, ultimately reducing the firm's ability to repay principal and interest. Thus, for firms with dynamic *CER* activities, the value-relevance and transparency of non-financial environmental information are high, resulting in lower costs for financing by lowering the environmental risk. As credit ratings can be unique measures for assessing the quantitative and qualitative aspects of the firms simultaneously, the measurement of *CER* performance with them enables shareholders, creditors, and regulators to effectively monitor corporate environmental actions and operations comprehensively.

Even though this conceptual relationship between *CER* activities and credit ratings is obvious, there are few empirical studies examining these associations. There are some studies using aggregate CSR measures rather than *CER* or the consequences from the equity market. For example, according to Dhaliwal et al. (2011), better performers in terms of CSR can enjoy a lower cost of equity capital, and this effect is especially large when they document separate CSR reports for the first time [15]. Additionally, CSR activities as well as CSR have the effect of lowering the cost of equity capital [31]. Regarding the debt

market consequences of CSR information, Goss and Roberts (2011) report that bank loan costs for firms with low CSR activities are higher compared to those for more responsible firms, yet they did not discover positive results on lowering interests for firms with high CSR investments [32,33]. A concurrent study by Jung et al. (2016) found that a firm's exposure to carbon-related risk is reflected in debtholders' lending decisions, when a firm shows its dedication to the management of related risk and efforts to decrease it through new capital investments using green technology [34]. Although a positive relationship between CSR and the cost of equity capital is quite clear, there are few empirical papers that examine *CER* activities and credit ratings, and there are no studies that have analyzed the relationship with a sub-dimension of *CER* activities. This is probably because these data are not available for free in Korea.

As mentioned earlier, as far as the shareholder theory holds, there will be a positive association between *CER* information and credit ratings. On the contrary, if bondholders do not reflect *CER* information in their pricing, there will be no relationship between non-financial environmental information and credit ratings. Based on the aforementioned arguments, I posit the following hypothesis.

Hypothesis 1. *Ceteris paribus, non-financial environmental information is positively associated with credit ratings.*

The effect of *CER* information on credit ratings can differ according to the degree of the agency problem between insiders and outsiders. Managers, who are representative of insiders, are generally better informed about corporate management activities and cash flows than are outsiders. If the information asymmetry between insiders and outsiders is sufficiently profound, the degree of monitoring efficiency and private information availability is attenuated. For example, Francis and Martin (2010) found that the positive relationship between financial reporting quality and investment decisions is more pronounced for firms with agency costs due to information asymmetry [35]. This evidence suggests that since it is costly for outsiders to evaluate management actions and overall firm performance for firms with greater information asymmetry [36], non-financial environmental information can be an important source that allows debtholders to monitor managerial actions. Based on these arguments, this study suggests the following hypothesis.

Hypothesis 2a. *The relationship between non-financial environmental information and credit ratings is contingent on the severity of the information asymmetry.*

Individual companies show different developments according to their own lifecycles. However, few papers have investigated whether strategic decisions regarding managerial *CER* activities are affected by the corporate lifecycle. Therefore, this study tried to infer the effect of the lifecycle on *CER* activities from previous studies on CSR, not *CER* activities.

There are two possible explanations for the motives for companies to engage in *CER* activities. On the one hand, managers can make *CER* investment decisions to compile ethical or reputation capital [34]. On the other hand, managers can make investments in *CER* based on an opportunistic motivation [35]. In this study, the lifecycle of a company was largely divided into two stages: the growth stage and the mature stage. Firms in the growth stage are more liable to engage in *CER* activities because growing firms need to raise reputation capital and financial performance for their sustainability at the same time. Since external stakeholders are key supporters helping *CER* firms to build up and link trust between insiders and outsiders, firms can raise the financial resources from stakeholders vital for starting incremental investments. Meanwhile, companies in the maturity stage may be able to do more or fewer *CER* activities. Because companies in the maturity stage have already secured sufficient financial resources and reputation capital, they can put less effort into *CER* activities than companies in the growth stage. Nevertheless, companies in the maturity stage recognize that *CER* activities are essential for the sustainable survival of companies. Thus, they have the potential to make *CER* investments more active by

using their spare resources. Following the aforementioned arguments, this hypothesis is proposed.

Hypothesis 2b. *The relationship between non-financial environmental information and credit ratings varies according to the corporate lifecycle.*

3. Research Design

3.1. Research Model and Variable Measurements

Based on the literature [36–39], the following regression model was used to predict the association between non-financial *CER* information and future credit ratings.

$$\begin{aligned} RATINGS_{t+1} = {} & \alpha_0 + \beta_1 E1_t + \beta_2 E2_t + \beta_3 E3_t + \beta_4 E4_t + \beta_5 E5_t + \beta_6 MO_t + \beta_7 FO_1 + \beta_8 INTCOV_t \\ & + \beta_9 MTB_1 + \beta_{10} LEV_1 + \beta_{11} ROE_1 + \beta_{12} AQ_1 + \beta_{13} BETA_1 + \beta_{14} SIZE_1 + \sum IND + \sum YR + \varepsilon_t \end{aligned} \quad (1)$$

where *RATINGS* = the natural logarithm of the bond credit rating (1–20); *E*1 = the corporate environmental strategy; *E*2 = the corporate environmental organization; *E*3 = the corporate environmental management; *E*4 = the corporate environmental performance; *E*5 = the communication with the stakeholders; *MO* = majority shareholders' ownership; *FO* = foreign investors' ownership; *INTCOV* = the interest coverage ratio (Earnings Before Interests and Taxes/interest cost); *MTB* = the market value of equity/book value of equity; *LEV* = the total debts/total asset; *ROE* = the net income/total equity; *AQ* = the earnings quality; *BETA* = the estimated value of beta, the number of months for five years before the relevant year as a variable corresponding to the systematic risk; and *SIZE* = the natural logarithm of the total assets in year *t*.

This paper employed the lowest bond credit rating data based on credit ratings assessed by three different credit rating agencies. It was intended to measure corporate credit ratings, conversely, in order to reduce bias in the proxy variable. For reference, three credit rating agencies in South Korea are Korea Ratings, Nice Investors Service Ratings, and Korea Investors Service Ratings. Specifically, I gave one point for the lowest C grade and two points for the next CC grade. Likewise, for the highest AAA grade, twenty points were given, and the next highest AA+ grade received nineteen points. This means that equivalent interval scores by stage were given to measure the corporate credit ratings. To control the endogeneity issues, the next term, credit rating variables, was used as a dependent variable. The model incorporated year fixed dummies and industry fixed effect dummies to permit variations across companies in the same industry–year observation. As far as each *CER* dimension has the ability to increase credit ratings, each coefficient represents a significantly positive value.

Next, the paper added subsample analyses by using the aforementioned model. To examine the effect of information asymmetry, stock return volatility was used. This was calculated using the standard deviation of the weekly market abnormal returns over the whole year, and these returns were used to mitigate nonsynchronous trading or bid–ask bounce effects in daily prices. Information asymmetry is high if a firm has an above-median stock return volatility, and vice versa. To investigate the lifecycles of the companies, this paper used Oswald's classification [40]. A maturity stage was defined as the steady state of a company as measured by R&D intensity. It was called a mature stage if the amount of R&D capitalization was similar to the degree of amortization. Specifically, if the discrepancy between the value of R&D capitalization and the amortization amount was less than the median value, the paper coded it as one, and otherwise, as 0. Similarly, if *CER* information was helpful for increasing future credit ratings, the coefficients in each equation would show significantly positive values. Furthermore, if one of the *CER* dimensions had a superior ability to increase future credit ratings, that coefficient would appear larger than those of the other variables.

The research model in this study included appropriate control variables that can influence credit ratings. These are majority shareholders' ownership (MO), foreign ownership (FO), the interest coverage ratio (INTCOV), the market-to-book ratio (MTB), the return on equity (ROE), the debt ratio (LEV), the earnings quality (AQ) as measured by Kothari

et al. (2005), the systematic risk (BETA), and the firm size (SIZE) [41]. Specifically, majority shareholders' ownership and foreign ownership were included to control for the effects of monitoring by majority and foreign shareholders. The interest coverage ratio (INTCOV) measures a corporate's capacity to repay its interests [42]. The market-to-book ratio (MTB) and return on equity (ROE) were included to measure corporate growth opportunity [43]. The LEV is a debt ratio that is measured as the ratio of total liability to total assets in year t. Firms with lower leverage were expected to show high creditworthiness and lower interest rates [44,45]. Earnings quality (AQ) was included because firms with higher quality earnings tend to have high solvency [41]. The estimation model for AQ is shown below in Equation (2).

$$\frac{TA_t}{A_{t\ 1}} = \alpha_0 + \beta_1 \frac{1}{A_{t\ 1}} + \beta_2 \frac{\Delta S_t\ \Delta AR_t}{A_{t\ 1}} + \beta_3 \frac{PPE_t}{A_{t\ 1}} + \beta_3 ROA_t + \varepsilon_t \quad (2)$$

where TA = the net income-cash flow from operations; S = the sales revenue; AR = the accounts receivables; PPE = plants, property, and equipment; ROA = the net income/total assets; and A = the total assets.

I used a cross-sectional model of discretionary accruals and estimated the model for every industry, classified by their two-digit industry codes. The sample included only firms with 15 or more firm-year observations to ensure sufficient data for parameter estimation. The residuals from the estimation model of Equation (2) were used to estimate the discretionary accruals. I used it after multiplying the negative one for the interpretation. Beta, which measures market risk, is based on the monthly rate of return data for the five years preceding the year and is expected to have a significant effect on the credit rating [46]. Finally, a larger firm size indicates resource capability for external finance at a lower cost [47].

3.2. Sample Selection

Table 4 displays the sample selection process of the paper. Companies that were listed in the Korea Stock Exchange (KSE) and Korea Securities Dealers Automated Quotation (KOSDAQ) market as of 31 December 2018 were included in the sample. They satisfied the following criteria: (1) firms excluding financial institutions; (2) firms on the KIS database that is maintained by Korea Investors Service, Inc.; and (3) firms with *CER* dimension data purchased from the KCGS. The extreme top and bottom 1% of all the variables including controls were winsorized to mitigate the influence of outliers. Table 4 represents the industry distribution of this study.

Table 4. The data description.

Industry	Number of Firms	%
Food/Tobacco	58	5.34
Textiles/Bags/Shoes	48	4.42
Paper/Wood/Pulp	38	3.50
Chemicals/Plastics	247	22.76
Primary Metals/Metalworking Processes	102	9.41
Machinery/Biotech	252	23.23
Construction	16	1.47
Wholesale/Retail	100	9.22
Service	224	20.65
Total	**1085**	**100**

4. Empirical Results

4.1. Descriptive Statistics

Table 5 presents the descriptive statistics for the main variables employed in this regression model. Except the *E*5 variable, most of the median values of the variables were larger compared to the mean values. Specifically, the average value of the credit ratings

(RATINGS) was 1.683, and the median value was 1.791. The mean (median) values for *E*1, *E*2, and *E*3 were 0.493 (0.590), 0.482 (0.583), and 0.412 (0.405), respectively. The mean (median) value of environmental performance, *E*4, was 0.119 (0.125), which showed lower values compared to the other *CER* dimensions. Finally, the mean value of environmental stakeholders (*E*5) was 0.310, which is larger than its median value of 0.200.

Table 5. Descriptive statistics.

Variables	Mean	STD	Q1	Median	Q3
CR_{t+1}	1.683	0.346	1.386	1.791	1.945
*E*1*t*	0.493	0.328	0.200	0.590	0.800
*E*2*t*	0.482	0.284	0.300	0.583	0.700
*E*3*t*	0.412	0.265	0.189	0.405	0.621
*E*4*t*	0.119	0.123	0.000	0.125	0.190
*E*5*t*	0.310	0.330	0.000	0.200	0.600

Notes: Variable definition: CR = the natural logarithm of the credit rating score, defined as the most conservative value from three different credit rating agencies (KBP, NICE, and KIS); *E*1 = environmental strategy; *E*2 = environmental organization; *E*3 = environmental management; *E*4 = environmental performance; *E*5 = environmental stakeholders.

4.2. Main Results and Discussion

Table 6 documents the results of the multivariate test of the first hypothesis based on a fixed-effect model. Such models contribute to controlling for the omitted variable issue because of unobserved heterogeneity where this heterogeneity is continuous over time. This type of heterogeneity can be deleted from the data through differencing, such as subtracting the group-level average over time. The results show that the coefficients for four *CER* dimension variables were positively significant, which together support Hypothesis 1. However, there were significant differences between the magnitude of each *CER* dimension. Specifically, the significance of *E*4, which represents environmental performance, was the largest, and *E*1, which represents the environmental strategy, had the lowest value, with insignificance. The next significant variable was *E*5, which measures the communication with stakeholders, and the next variable was *E*4, which represents environmental management. These significant coefficients support the evidence that credit ratings incorporate non-financial information on corporate environmental activities in their assessments. To be more precise, it was found that companies with good environmental performance in terms of resources, climate change, environmental laws and regulations, and eco-friendly products and services are given better credit ratings. Next, companies with active responses to stakeholders such as timely environmental reporting, appropriate activities in response to stakeholders, post-treatment activities after the violation of environmental laws and regulations, and responses to disputes caused by environmental complaints were provided better credit ratings. As a result of the empirical analysis, the third factor that significantly affects credit ratings among environmental information was found in the environmental organization sector, where the environmental organization is a variable that determines whether the environmental organizational culture and environmental organizational system are well formed. In sum, it was found that the higher the credit rating, the stronger the activities of the *CER* components, where the discretion of the management was relatively less reflected, as were the activities objectively perceived as environmentally friendly by external stakeholders. For this reason, this study infers that the environmental management and strategy areas, where volatility is relatively largely at the discretion of the manager, has relatively low or no significance.

Table 6. The impact of corporate environmental responsibility (*CER*) activities on credit ratings.

Variables	Coeff.	*t*-Stat.
*E*1	0.005	0.98	
*E*2	0.020	1.96	*
*E*3	0.019	1.67	*
*E*4	0.061	3.06	***
*E*5	0.065	2.51	**
MO	−0.073	−5.18	***
FO	−0.176	−8.81	***
INTCOV	0.000	3.76	***
MTB	−0.002	−1.63	
LEV	0.035	15.21	***
ROE	−0.071	−5.80	***
AQ	0.290	7.41	***
BETA	0.021	3.78	***
SIZE	0.008	19.11	***
Industry Dummy	Included	
Year Dummy	Included	
R^2	0.93	
F-stat.	661.73 ***	
N	1085	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) *RATINGS* = the natural logarithm of the bond credit rating (1–20); *E*1 = corporate environmental strategy; *E*2 = corporate environmental organization; *E*3 = corporate environmental management; *E*4 = corporate environmental performance; *E*5 = communication with the stakeholders; *MO* = majority shareholders' ownership; *FO* = foreign investors' ownership; *INTCOV* = interest coverage ratio (Earnings Before Interests and Taxes/interest cost); *MTB* = market value of equity/book value of equity; LEV = total debt/total assets; *ROE* = net income/total equity; *AQ* = earnings quality; *BETA* = estimated value of beta, the number of months for five years before the relevant year as a variable corresponding to the systematic risk; *SIZE* = the natural logarithm of total assets in year t.

Next, Table 7 represents the empirical results from testing the second hypotheses. Similar to those in the previous table, all the statistics were evaluated from a fixed-effect model. First, Hypothesis 2a predicts that the association between *CER* activities and credit ratings is more pronounced for firms with high information asymmetry, and vice versa. Based on the degree of the agency problem between managers and outside investors, the effect of *CER* activities may vary. In most cases, insiders hold more incremental information regarding the managerial activities and performance of companies compared to external shareholders. If profound information asymmetry exists between managers and external investors, the management, who have a competitive position, may take opportunistic positions, employing private information for private interests. In these circumstances of information disadvantages, information about *CER* activities is likely to be more value-relevant to external investors. This paper used stock return volatility, measured as the standard deviation of market excess returns per week, as a proxy for information asymmetry between managers and external investors. High stock return volatility, as a measure of information asymmetry, meant that firms had stock return volatility above the median in year t. As a result of the empirical analysis in Panel A of Table 7, it was found that in the sample with high information asymmetry, two of the environmental variables had significant effects on receiving a better credit rating. By contrast, in the sample with low information asymmetry, no variables were significant. These results can be interpreted as showing that the higher the information asymmetry in the information environment, the more corporate *CER* activity tends to signal to external investors, "our company is environmentally friendly". Therefore, this study found that the higher the information asymmetry, the higher the *CER* activities, and the more non-financial environmental information contributes to receiving a higher credit rating.

Table 7. The impact of the information environment on the relationship between *CER* activities and credit ratings.

Panel A. Information Asymmetry				
Variables	**High Information Asymmetry**		**Low Information Asymmetry**	
	Coeff.	**t-Stat.**	**Coeff.**	**t-Stat.**
*E*1	0.005	0.34	0.001	0.11
*E*2	0.012	0.47	0.024	0.93
*E*3	0.003	0.07	0.012	0.49
*E*4	0.038	2.19 **	0.003	0.32
*E*5	0.070	2.17 **	0.022	0.70
MO	−0.107	−5.43 ***	−0.034	−1.71 *
FO	−0.210	−6.55 ***	−0.116	−4.52 ***
INTCOV	0.000	2.28 **	0.000	−2.76 ***
MTB	10.002	−1.68 *	−0.005	−1.87 *
LEV	0.029	9.83 ***	0.040	11.20 ***
ROE	−0.051	−3.49 ***	−0.145	−5.70 ***
AQ	0.266	5.13 ***	0.304	5.31 ***
BETA	−0.009	−1.15	0.017	1.93 *
SIZE	0.011	17.35 ***	0.008	13.30 ***
Industry Dummy	Included		Included	
Year Dummy	Included		Included	
F-value	384.62 ***		317.14 ***	
Adj. R^2	0.94		0.92	
Observations	495		590	
Panel B. R&D State				
Variables	**A Maturity Stage**		**A Growth Stage**	
	Coeff.	**t-Stat.**	**Coeff.**	**t-Stat.**
*E*1	0.017	1.14	0.016	0.61
*E*2	0.089	2.54 **	0.037	1.27
*E*3	0.027	1.03	0.053	1.40
*E*4	0.087	2.96 ***	0.030	1.66 *
*E*5	0.039	2.76 ***	0.001	0.01
MO	−0.070	−3.56 ***	−0.061	−2.90 ***
FO	0.145	−5.09 ***	−0.201	−7.20 ***
INTCOV	0.000	2.50 **	0.000	2.59 ***
MTB	0.009	−3.42 ***	0.002	1.18
LEV	0.036	12.16 ***	0.032	8.94 ***
ROE	−0.095	−5.32 ***	−0.052	−2.99 ***
AQ	0.288	5.32 ***	0.298	5.44 ***
BETA	0.019	2.62 ***	0.020	2.32 **
SIZE	0.009	15.08 ***	0.008	12.52 ***
Industry Dummy	Included		Included	
Year Dummy	Included		Included	
F-value	381.68 ***		298.55 ***	
Adj. R^2	0.94		0.92	
Observations	541		544	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 5 for definitions of other variables.

Second, Hypothesis 2b is that there is a difference in the impact of *CER* activities on credit ratings according to the lifecycle of a company. Before testing, it was not clear whether firms in a maturity stage were likely to engage in more or fewer *CER* activities, compared to firms in other stages. On the one hand, mature companies have ample internal capital and resources to invest in *CER* activities. Since internal resource availability includes the costs for *CER* activities, mature firms may be likely to engage in *CER* activities more, relative to other companies in other lifecycle stages. On the other hand, there is a possibility that firms in maturity stages are less likely to increase investment for *CER* activities since they have already compiled ample reputation capital. Nonetheless, even for firms at a maturity stage, compiling incremental ethical reputation is still important for corporate survival and sustainability. Thus, this paper set no ex ante expectations regarding *CER* activities among mature-stage firms. The coefficients of *E*2, *E*4, and *E*5 in Panel B of Table 7 show statistically significant positive values

at least at the 5% significance level, supporting H2b, which expects that firms in maturity stages are more likely to show strong relationships between *CER* and credit ratings. However, in the second column, only the coefficient of *E*4 is positive and significant at the 10% level, still supporting Hypothesis 2b in that firms in growth stages have less-strong associations between *CER* activities and credit ratings. The aforementioned empirical outcomes have significant implications for both management and outside stakeholders in that there is a different impact of lifecycle on the relationship between *CER* and credit ratings, since the capacity and the propensity for investing in *CER* activities vary across corporate lifecycle stages.

Overall, in spite of the different impacts of each *CER* activity, the effect of *CER* activity on the credit ratings implies that credit rating agencies incorporate non-financial *CER* information in their solvency assessment processes, considering whether reputational capital related to environmental activities reduces information risk. These empirical results are consistent with the stakeholder theory, meaning that *CER* activity is a key factor in securing essential resources for corporate survival and financial support from stakeholders [8]. Furthermore, the positive relationship between *CER* activities and credit ratings shows that these activities help to alleviate the agency problem stemming from information asymmetry between management and outside investors. Finally, firms with high degrees of information asymmetry and mature firms are more likely to send a strong signal to credit rating agencies regarding eco-efficiency and enjoy benefits in the form of lower costs of debt financing due to high credit ratings [7].

4.3. Additional Tests: Firm-Year Clustering Analyses

There can be two circumstances that make *CER* dimension variables endogenous. First, there can exist either causality operating from credit ratings to *CER* activities, or causality operating mutually. If there is a random event that influences the regression analyses by the error term, it may be able to influence the credit rating variable. This is because future credit ratings influence *CER* activities, and *CER* dimensions can relate to the error term part, resulting in an inappropriate coefficient for each *CER* dimension. Second, *CER* activities and future credit ratings are not directly related to each other. Rather, they show spurious correlations due to unknown or omitted variables. If the regression model cannot control for the omitted variables, the effects of these variables will be reflected in the error term, thereby causing inappropriate and biased estimation. To resolve these types of problems, this study employed Petersen's firm-year clustering analyses [48]. Based on this method, this study could control for two possible issues: (1) residuals not having equal distributions, and (2) an association between the groups of residuals being existent [48]. By doing this, we could calculate more conservative values for the t-statistics.

Table 8 presents the results of the firm-year clustering analyses. Overall, it seems that the results are similar to the main regression results, suggesting that the association between *CER* activities and future credit ratings was significant, despite the fact that the robustness was increased.

Table 8. Firm-year clustering analyses.

Variables	Coefficient	t-Stat.
Intercept	0.242	19.98 ***
*E*1	0.005	0.54
*E*2	0.021	1.79 *
*E*3	0.004	0.22
*E*4	0.036	1.75 *
*E*5	0.061	2.27 **
Controls		Included
Adjusted R^2		0.43
F-stat.		40.59 ***
observations		1085

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 5 for definitions of the variables.

4.4. Additional Tests: Endogeneity Tests by Using Propensity Score Matching Method

When explanatory variables and error terms are correlated in a testing model, there may exist a reverse causality problem, which leads to biased estimation. If we interpret these circumstances, most corporate decision making is endogenous. The main findings in the paper imply that credit rating agencies perceive that firms with high *CER* activities are more creditworthy. These findings indicate that credit rating agencies are properly and efficiently incorporating non-financial *CER* information into rating processes. However, this interpretation may not hold if the outcomes are contingent with specific corporate characteristics that are endogenous to credit rating evaluation.

Thus, the propensity score matching (PSM) method, which controls for the possible endogeneity issues in credit rating agencies' assessment behavior, was applied. First, I employed a logistic regression to estimate propensity scores.

$$CER_t = \beta_0 + \beta_1 SIZE_t + \beta_2 LEV_t + \beta_3 ROA_t + \beta_4 CHAEBOL_t + \beta_5 FOR_t + \beta_5 LOSS_t + \varepsilon_{t+1} \quad (3)$$

where *CER* = a dummy variable that equals one if a firm has an above-median *CER* score in year t and 0 otherwise. Each *CER* dimension was regressed, respectively, and the five specific *CER* dimensions were *E*1 (the corporate environmental strategy score), *E*2 (the corporate environmental organization), *E*3 (the corporate environmental management), *E*4 (the corporate environmental performance), and *E*5 (communication with the stakeholders); *SIZE* = Ln (the total assets); *LEV* = the total debt/total assets; *ROA* = the net income/total assets; *CHAEBOL* = an indicator variable that equals one if a firm belongs to a chaebol group and 0 otherwise; *FOR* = the percentage of outstanding common shares held by foreign investors in year t; *Loss* = 1 if the current net income is lower than 0 and 0 otherwise.

In a subsequent procedure, firms with better *CER* activities were matched to firms with lower *CER* with the closest forecasted values from Equation (3) within a maximum distance of 3% [49]. Firms with better *CER* activities that could not be matched with any low-*CER* firms were excluded from the tests because forecasted values for the latter firms were not incorporated within the identified distance of 3%. Accordingly, there was a reduction in the number of data compared to that in the main regression tests.

Table 9 reports the evidence according to the propensity score matching method, and it is qualitatively consistent with the results supporting the main hypothesis. This indicates that *CER* activities represent a crucial factor in determining the creditworthiness of a company as judged by credit rating agencies even when controlling for the potential endogeneity issues.

Table 9. Endogeneity test using propensity score matching method.

Variables	Coefficient	t-Stat.
*E*1	0.005	0.95
*E*2	0.020	2.03 **
*E*3	0.018	1.63
*E*4	0.060	3.02 ***
*E*5	0.066	2.54 **
Controls	Included	
Adjusted R^2	0.93	
F-stat.	664.88 ***	
observations	986	

(1) **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 5 for definitions of the variables.

4.5. Additional Tests: Two-Stage Least-Squares (2SLS) Regression Analysis

Another form of endogeneity problem can be driven by unobservable firm and CEO characteristics. For instance, firm culture, CSR performance, firm ownership, and, more importantly, corporate governance can be channels impacting the information environment, credit rating, and *CER* information. To assess these types of endogeneity issues, I conducted a two-stage least-squares (2SLS) regression analysis. This regression included a two-stage

procedure, and in the first stage, I regressed all the potentially endogenous variables on all the exogenous explanatory variables. Next, I obtained the predicted values from the possibly endogenous variables by employing estimated coefficients from the first stage. In the next stage, I regressed the credit ratings on the exogenous explanatory variables and predicted values obtained in the first stage. The instrumental variables included the CSR score, corporate governance index score, firm size, leverage, return on assets, and earnings volatility.

Table 10 presents the evidence from the 2SLS regression analysis using samples of credit ratings based on each *CER* score, where *E1hat–E5hat* are the estimated *CER* variables from the first stage. As a result, most of the *CER* dimensions remained positive and significant, suggesting that the main findings in this paper are robust even when I control for the potential endogeneity problem.

Table 10. Two-stage least-squares (2SLS) regression analysis.

Variables	Coefficient	t-Stat.
E1hat	0.004	0.75
E2hat	0.021	2.06 **
E3hat	0.022	1.92 *
E4hat	0.059	2.88 ***
E5hat	0.065	2.46 **
Controls	Included	
Adjusted R^2	0.92	
F-stat.	631.34 ***	
observations	1085	

(1) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. (2) See Table 5 for definitions of the variables.

5. Conclusions

In the past 25 years, the global economy has experienced rapid growth in the number of firms that assess and document environmental issues such as carbon emissions, water consumption and pollution, and waste generation. Compared to the early 1990s, when fewer than 20 firms disclosed environmental information, more than 9000 firms in 2016 reported sustainability or integrated reports, which proves investors' interest in environmental investments. In 2019, environment-related mutual funds drove net inflows of USD 20 billion, beating the previous year's report by over four times [50]. Introductions to these funds intensified more, even during the first quarter of the COVID-19 pandemic in 2020, with proponents appealing that corporate environmental activities have exerted risk-adjusting functions [51].

In these circumstances, this paper adds to the corporate credit rating literature by employing non-financial attributes incorporated in *CER* activities to provide details on the quantitative and qualitative parts of corporate credit ratings. According to the shareholder theory, *CER* activities lead to internal resource consumption, thereby increasing corporate default risk, whereas the stakeholder theory makes the opposite claims. It suggests that *CER* activities aid debt markets by a decrease in information asymmetry between insiders and outsiders, thereby decreasing the perceived litigation risk for firms. Specifically, this paper examined which dimensions of non-financial environmental information were reflected more in credit ratings.

The sample in this paper consisted of 1085 firms in South Korea in the period 2013–2018. As a result of empirical analysis, this study reported that *CER* contributed to obtaining a better credit rating through the dimensions of environmental performance, communication with stakeholders, environmental organization, environmental management, and environmental strategy, which is consistent with the stakeholder theory. In addition, the association between each *CER* activity and the credit rating is more pronounced for information environments with higher degrees of information asymmetry and for firms in mature stages. These results indicate that credit rating agencies value relatively objective

CER information more than the other types, and they are more likely to employ certain *CER* information to evaluate the creditworthiness of firms with high degrees of information asymmetry and firms in maturity stages.

The contribution of this study lies in three aspects. First, the research outcomes document that creditors recognize that firms with high degrees of *CER* activities are more credible, and all five *CER* dimensions are considered. These results also indicate that credit rating agencies include non-financial *CER* information in the rating process efficiently; however, the reputation capital aspects of each *CER* dimension valued in the equity market may be captured by credit ratings differently. According to the Securities Industry and Financial Markets Association, the major source of external financing is corporate bond financing. Specifically, U.S. corporations issue a total value of USD 11.2 trillion in bonds, whereas the total value of stock issuance between 1992 and 2009 was USD 3.1 trillion. Thus, understanding the debt market consequences of *CER* activities is crucial and intriguing in its own right.

Second, the outstanding findings in this paper provide quite a few practical suggestions. The findings in this study and the literature show that firms that are engaging in CSR activities can enjoy lower costs for debt financing. These results suggest that although *CER* activities sacrifice scarce resources, their benefits through reducing financing costs can be higher. From the perspective of regulatory and standard-setting bodies, the finding that the Korean debt market evaluates non-financial environmental information further supports the government's green policies highlighting *CER* activities. Moreover, from the perspective of credit rating agencies, the findings can help rating agencies to appreciate the relationship between the non-financial aspects of firms' activities and credit ratings. The outcomes in this paper may encourage companies to disclose non-financial environmental information voluntarily, thereby forming a transparent information environment for external investors who want to invest in *CER*-intensive firms based on their precise assessment.

Finally, this paper shows novelty in the unique data set gained from the KCGS, which permitted measuring sub-dimensions of *CER* activities. Specifically, the five *CER* subdimensions studied were corporate environmental strategy, organization, management, performance, and the communication of environmental information to stakeholders. The advantage of using this data set was that it allowed analyzing which factors had the greatest influence on credit ratings. In other words, instead of employing a comprehensive measure of CSR as in the literature, the study isolated the effect of each dimension of *CER* activities on credit ratings. This paper documents evidence that among the five *CER* dimensions, the factor of high discretion of the manager has a relatively weak influence on the credit rating, and the more objective *CER* dimensions increase the credit rating.

In spite of the fact that this paper sheds light on the CSR-related literature, it shows several limitations that should be addressed in future research. First, even though this paper used unique data obtained from the KCGS and credit rating agencies that are widely accepted in the finance and accounting area, they are actually a secondary data set. If possible, collecting primary data such as through developing a more sophisticated index for measuring pro-environmental activities manually and voluntarily, and interviewing management in credit rating agencies on the rating processes could persuasively support the results. In addition, the relationship between *CER* activities and credit ratings might be dependent upon the omitted variables, resulting in endogeneity issues. Second, this study employed the credit ratings to measure the corporate costs of debt financing. However, this measure could be noisy and unstable if firms are not assessed by rating agencies and have no credit ratings. To overcome this caveat, future studies should incorporate developed and sophisticated measures of the cost of debt financing. Lastly, this paper only focused on listed firms in South Korea. However, for future research, it would be more intriguing to expand the data to include developed countries such as the U.S. and those in the EU and to compare the effect of *CER* practices on the cost of debt financing. In particular, according to previous studies, investors in Europe appear to constitute an investment portfolio that emphasizes impact

investing or eco-efficiency [52–54]. However, investors in emerging markets are still in the early stages of impact investing. For this reason, if future research deals with the comparison of CSR investor patterns in developed and developing countries, interesting research results in various cultures and settings of different institutions can be expected.

Nevertheless, this study is crucially meaningful, as this is the first paper to investigate the effect of each dimension of *CER* activities on credit ratings in South Korea. The existing literature documents the impact of CSR not *CER* disclosure on the cost of equity capital [15] and the cost of private debt [16]. However, this paper took a step further and studied the effect of sub-dimensions of *CER* activities on credit ratings, which were calculated by comprehensively judging quantitative and qualitative factors by securing more detailed data regarding CSR activities. In future studies, it would be intriguing to study how many grades the actual credit rating increases by or how, specifically, the cost of debt financing decreases when increasing investments for certain dimensions of *CER* activities. If data collection is possible, there will be great implications for comparing *CER* data with other components of CSR activities.

Funding: This work was supported by an Incheon National University (International Cooperative) Research Grant in 2017.

Conflicts of Interest: The author declare no conflict of interest.

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