

## Article

# Voluntary Disclosure of Carbon Emissions and Sustainable Existence of Firms: With a Focus on Human Resources of Internal Control System

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**Abstract:** The purpose of this study is to examine the relationship between the voluntary disclosure of carbon emissions and firm value. In addition, we examine whether the human resources of the internal control system affect the relationship between the voluntary disclosure of carbon emissions and firm value with data from the Korean stock market from 2014 to 2019. This study shows that the firms that voluntarily disclose information on carbon emissions increase their value. Additionally, the sufficient number and working experience of internal control personnel in each accounting, financing, and information technology department positively affects the relationship between voluntary disclosure and firm value. We additionally find an effect of the awareness level on climate change on firm value. That is, firms that are active on climate change rather than merely disclosing information. Finally, we find the positive role of Environment, Social and Governance (ESG), implying a superior management environment that leads to better disclosure practices.

**Keywords:** voluntary disclosure; carbon emission; operation of internal control system; firm value; Carbon Disclosure Project



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## 1. Introduction

This study analyzes the effect of human resource investment in the internal control system on the relationship between voluntary carbon emission disclosure and firm value. Environmental issues have been raised for a long period. For example, the Arctic Climate Change Update 2021 reports that the temperature in the Arctic is three times higher than the global average during the period between 1971 and 2019. As carbon emissions, global warming, and abnormal climate phenomena are frequently shown, many countries have sought effective countermeasures. Because of the severity of climate changes, on 14 June 2021, the Group of 7 (G7) agreed to move forward with climate change and proposed to raise USD 100 billion annually to help developing countries reduce emissions. In the final statement, the leaders of G7 agreed to put all their effort into achieving zero net carbon emissions by 2050 at the latest.

Investors view climate risk as a new opportunity to survive in a capital market. According to the research of Price Waterhouse Coopers (2012) [1], sustainable development in the aspect of climate change has increased eighteen times in the past ten years. Many activities provide investors with environment-related information and new investment guidance, and one of these is the Carbon Disclosure Project (CDP) in the U.K.

Recently, in South Korea, public interest in climate change has increased, and the need for disclosure of corporate environmental information and carbon emission has emerged. Therefore, in 1996, South Korea stipulated that environment-related information could be included in supplementary notes to financial statements as a part of the process of

corporate accounting standards of the Securities and Exchange Commission. Then, from 1998, the Financial Supervisory Commission required firms to include information such as corporate environmental policies and standards, environmental investment, resource and energy consumption, and waste disposal in their financial statements. However, it is not clear what kind of explicit content should be included. Additionally, because views on the notes of financial statements may differ by for each company and the provision is not compulsory, it is possible for firms to overlook the importance of objectivity and the qualitative level of environmental accounting information disclosure.

As public attention has increased concerning carbon emissions, managers are under pressure to disclose information, which can be an important factor in assessing firm value. According to prior research, the value-added asset theory asserts that firm value would increase due to environmental disclosure, while firm value would decrease under the altruistic liability theory. With the presence of conflicting theories, we investigated the effect of voluntary disclosure on carbon emissions concerning firm value.

Voluntary disclosure is a process of managers transmitting information to the market to reduce information asymmetry between management and investors (Healy and Palepu, 2001) [2]. Information asymmetry means that management is expected to have more privileged information than existing or potential investors. Disclosing information helps mitigate the adverse selection of poor risk investments and related moral hazards (Beaver, 1998) [3] and efficiently allocates resources (Kim et al., 2017) [4]. Voluntary disclosure leads to decreased uncertainty, less risky and more credible firms, affects financial performance, and ultimately firm value (Plumlee et al., 2015) [5].

However, there is no guarantee that a firm's transparency will be improved by introducing the system. In addition, if information disclosure is provided indiscriminately to the outside without any filtering process, it will increase the cost of information users, and the information effect of the public announcement will be reduced. As high-quality and reliable information should be disclosed externally, which may enhance corporate transparency, an empirical analysis of whether introducing a system for strengthening transparency has improved the quality of disclosure by the actual firms is of great significance in this respect.

We consider the human resources in the internal control (IC) system to acquire reliable information. The IC system is designed to improve operating performance by preventing any possible fraud (Baltaci and Yilmaz 2006) [6]. In the United States, fraudulent accounting cases such as Enron and WorldCom, which occurred one after the other in the early 2000s, raised the need to build and strengthen a system for monitoring management fraud. As a result, the Sarbanes–Oxley Act (SOX) was enacted in 2002. SOX Article 404 requires firms' management to establish and evaluate IC to improve the quality of disclosure of financial statements while at the same time having external auditors review the adequacy of the IC system. The legislation shows that establishing an appropriate IC system is necessary for improving the credibility of accounting information, and South Korea also introduced the IC system to improve the reliability of accounting information. In order to build the system, the provision of an IC system was included in the Corporate Restructuring Promotion Act in 2001. The report on IC operation has been revised so that the business report will additionally announce the number of employees, the status of possession of Certified Public Accountant (CPA), and working experiences. Recently, legislation on the new Audit Act in 2019 has emphasized for the IC system to be audited.

While previous studies have examined the effect of IC systems and IC opinion, we focus on the IC system at the operation level. For IC systems to be effective, they must be premised on sufficient human resource investment because the personnel in charge carry out the specific procedures of the IC system. Additionally, firms with sufficient human resources and more working experience ensure timely reviews, the adequate segregation of duties, and monitoring of reporting quality. For this reason, the framework of the Committee of Sponsoring Organizations of the Treadway Commission (COSO 1992) [7] emphasizes that sufficient human resources are inevitable for the control of an IC system. At the same time, the Public Company Accounting Oversight Board (PCAOB 2008) [8] in

2008, expressed concern that firms would reduce their investment in the IC system under a global financial crisis and asserted that the reduction in the IC investment would hinder its effective operation, thus undermining the credibility of reporting quality. Despite the importance of the role of the investment level in the personnel in charge in the effective operation of an IC system, studies on the human resources in an IC system have not been conducted. Therefore, to fill the gap, we examine the role that the human resources in the IC system play in the effect of disclosing information about carbon emissions on the firm value.

Using 734 firms from 2014 to 2019, we found a positive association between voluntary disclosures affecting firm value. This result suggests that disclosing carbon emissions as a part of the CDP is a relevant and trustworthy mechanism, resulting in higher firm value. We also found that the effective operation of IC positively affects the relationship between voluntary disclosure and firm value. When the firm has sufficient IC personnel, the proper segregation of duties and the timeliness of accounting functions are anticipated. Through well-equipped IC operation, the possibility of errors is reduced, thus enhancing the relationship between voluntary disclosure and firm value. The result of this study is interpreted as the IC system playing the role of a regulator that efficiently monitors management and ensures the reliability of corporate disclosure. It is interpreted as a result suggesting that the opportunistic behavior of management, which can mislead shareholders, can also be effectively controlled by the appropriate human resources in the IC system. For the additional tests, we found that the awareness magnitude of climate change affects the firm value. The result suggests that when firms actively take action on climate change, they increase firm value. We also tested the ESG on the relationship between voluntary disclosure and firm value. We found that the ESG plays a positive role since those firms with ESG are expected to have a superior management environment and better disclosure practices.

This study makes several contributions to the extant literature. We are the first to measure the IC system at the operation level with a relationship between voluntary carbon emission disclosure and firm value. In order to effectively operate the IC system, in addition to characteristics such as the size and financial status, the personnel in charge of IC, and who is the operating entity of the IC system, it is essential to consider the quantitative and qualitative aspects. Therefore, in this study, the IC personnel's quantitative and qualitative aspects, using the number of personnel and the average working experience measured in months, which is published only in Korea, are utilized. Since the data on the human resources of the IC system are not available in other countries, previous studies have measured whether the firms have material weaknesses or not in the IC system, and it has a limitation of dichotomy. However, human resources information on the IC system used in this study can confirm the effectiveness level. The result suggests that firms investing in human resources for IC directly answer the question of whether investments lead to transparent financial reporting. Moreover, our findings will be of particular interest to regulators such as the Financial Supervisory Service (FSS, the counterpart of the SEC) as they try to establish and develop regulations regarding human resource investments and appropriate disclosure to enhance efficiency in the capital markets.

The study supports that the IC system is an integral component of corporate governance that can help ensure the reliability and integrity of disclosure. It is interpreted as a result that opportunistic behavior of the management can be effectively controlled through the use of human resources.

This study is also meaningful in examining how firms perceive and interpret climate change as a factor that has an impact. This study contributes to the academic practice that analyzed the perceptions of Korean firms on climate change with CDP data. The difference in the perception of potential risks and opportunity factors on climate change can affect firm value.

The remainder of this paper is as follows. First, Section 2 explains the backgrounds and hypotheses. Then, Section 3 describes the research design and sample description. Finally, Section 4 explains the empirical results, and Section 5 explains the conclusion.

## 2. Backgrounds and Hypotheses

### 2.1. Voluntary Disclosure of Carbon Emission

Carbon emission is becoming increasingly important for stakeholders who are interested in the effects of global warming. Stakeholders demand transparent information and firms tend to disclose their real obligations to fulfill their commitment and to improve their environment-based decision making (Datt et al., 2018) [9]. Additionally, to cope with the rising attention on the environment, firms may have the intent of persuading stakeholders that they are concerned about the environment and voluntary disclosure is a way to spread the message. Managers are also under pressure to monitor, manage, and disclose firms' carbon emissions. Such disclosures of environmental information can be an important factor in assessing corporate value. It has been argued that non-financial information such as environment information can explain firm value, while traditional financial elements are not enough (Simnett et al., 2009) [10].

There are two theories that explain the effect of environmental disclosure on firm value. First, there is a value-added asset theory that disclosing environmental issue can positively affect firm value (Lee and Jeon, 2019; Byun and Yi, 2012) [11,12]. In other words, disclosing the firm's level of environmental status leads to an increase in firm value because firms that reveal their environment-concerned investments are innovative, complying with the environmental regulation, and this improves the firm's image as environmentally-friendly (Christmann, 1998) [13]. For example, Matsumura et al., (2014) [14] examined the effect of carbon emissions on firm value by comparing the firms with disclosing information and firms without. They found that all firms are punished by their carbon emissions, while firms that do not disclose their carbon emission are subject to an additional penalty. Choi and Noh (2016) [15] conducted an analysis using CDP information disclosed in South Korea. They suggested that reducing the amount of carbon emissions by a company increased the corporate value, and so does the voluntarily disclosing of information on carbon emissions. In other words, this suggests that the information on carbon emissions disclosed by firms is useful for investors.

Firms that voluntarily disclose information about carbon emissions, which can be negative information, will signal that they are performing their required social responsibilities in good faith. Datt et al. (2019) [9] found that firms use carbon performance as a signal when they are better than other firms. In other words, firms with a high performance in their use of voluntary CDP are more engaged in reporting their commitment to controlling carbon emissions. Managers in high performance are likely to control carbon emissions and incorporate this into their firm's strategy, such as innovative carbon reduction actions that are supported by financial resources, which are hard to imitate. In addition, the result suggests that CDP reports are effective for carrying reliable information on carbon performance.

However, according to the theory of altruistic liability theory, firms that emit pollution carry self-responsibility to improve and solve environmental issues, and this investment is rather costly (Lee and Jeon, 2019, Byun and Yi, 2012) [11,12]. Firms sacrifice the rising manufacturing cost to comply with responsibility. Thus, firm value will decline because investors recognize the investment as expense. Gray and Shadbegian (1983) [16] stated that when firms try to allocate assets and human resources to follow the environmental regulations, per capita productivity may be hindered. Cohen (1995) [17] found that firms that emit vast pollutants are more profitable than firms that invest in facilities to reduce environmental pollution. Carbon emission is considered a culprit of global warming and is regulated by environmentally harmful substances. Based on altruistic liability theory, if the firm discloses information on carbon emission, it means that the firm accepts the

disadvantages of rising costs and various taxes related to carbon emission, which may result in lowering firm value.

## 2.2. Human Resources in Internal Control

In the early 2000s, the Sarbanes–Oxley Act (SOX) was enacted after a series of fraudulent accounting scandals such as Enron and WorldCom raised the need to strengthen the system to prevent the distortion of financial information and monitor management fraud. SOX 302 and 404 stipulate the contents of the IC system. SOX 302 clarifies that the management is responsible for establishing and operating the IC system, and is required to disclose the operating state through the IC report as a part of the business report. COSO have published an IC integrated framework, widely used all over the world (COSO 1992) [18]. To accomplish financial reporting objectives, COSO proposes IC's five components: control environment, risk assessment, control activities, information and communication, and monitoring activities. COSO suggests that sufficient personnel holding responsibilities for each IC function may positively affect the basic control activities in many areas, including the adequate segregation of duties, independent reconciliations, and management review (COSO 1992) [7].

The IC system in Korea is also based on the COSO framework, as are IC systems in the U.S. and other countries. Article 2-2 of the External Audit Act in Korea states that the IC system should help prepare and disclose reliable financial information and clarifies that firms should have departments, such as accounting, finance, and IT. At the same time, it requires listed firms to report their operating status in their annual reports. Specifically, the total number of IC personnel and their working experience measured in months in each department must be disclosed. The reason for forcing firms to disclose information regarding the operating status of their IC system is to provide the basis for evaluating the effectiveness of the IC system by external shareholders. In other words, firms that have invested more in the human resources in charge of the IC system reflect the expectation that the IC system will be operated more effectively. Just as the personnel influence the effective operation of the IC system, the characteristics of the human resources in the IC system may offer helpful information to understand the effectiveness of the IC system (Ryu et al., 2012) [19].

Having sufficient or more experienced IC personnel means being involved in the process in detail to provide a better quality of accounting information. At the same time, sufficient IC personnel can reduce risks by strengthening internal monitoring and controlling the reporting process (Ma and Jung 2016) [20]. In this way, the IC system provides more reliable financial information to the market by stipulating control procedures related to the preparation and reporting of accounting information, leading to reduced information asymmetry.

The research related to the human resource investment in IC systems has been actively conducted in South Korea because information on the characteristics of the human resources in IC systems is particularly disclosed in South Korea. Ge and McVay (2005) [21] found that the material weaknesses of the IC system are caused mainly by the lack of qualified IC personnel, asserting that expertise and sufficient human resource of an IC system are inevitable. Ryu et al. (2012) [19] analyzed the relationship between the characteristics of the IC human resource and the possibility of an accounting error. As a result of the analysis, the higher the IC personnel ratio is, the higher the average working experiences, the less likely accounting errors occur. This implies that the human resource investment in the IC system leads to transparent reporting. Ji et al. (2013) [22] found a relationship between the professionalism of IC personnel and earnings management. They suggest that professionalism and the number of IC personnel are negatively related to discretionary accruals, meaning that sufficient personnel with expertise holds back the opportunity to manipulate earnings. Bae et al. (2014) [23] analyzed the relationship between the IC personnel and fraudulent accounting. Sanctioned firms were used as the proxy for fraudulent accounting, and the result suggests that firms with an increasing number of IC personnel report a

lower possibility of enforcement action. Shin et al., (2014) [24] investigated the effect of both qualitative (the number of CPAs to total employees in the financial department) and quantitative (the proportion of employees to total employees) human resource investment on the analyst forecast. As a result, firms with a higher ratio of CPA, implying more experienced IC personnel, in the finance department report accurate analyst forecasts and less forecast dispersion. These studies discussed above suggest that the systematic and effective operation of an IC system increases the transparency of accounting information and improves the efficiency of resource allocation in the capital market.

### 2.3. Hypothesis Development

As global increases in greenhouse gases have created severe environmental problems, managers are under pressure to disclose the information on carbon emissions. This is non-financial information transmitted to relevant investors that will reduce the information asymmetry between managers and shareholders regarding carbon emissions. Firms that participated in the voluntary disclosure of carbon emissions are expected to have high-quality staff and innovative technology (Surroca et al., 2010) [25], improving energy efficiency and their operating process. Additionally, firms participating in an environmental initiative, such as CDP, are regarded as strengthening their environmental responsibility and are supported by stakeholders (Flammer 2013) [26]. In turn, such activities may induce firms' reputations to manage their legitimacy and reduce financial risk (Alsaifi et al., 2020) [27]. It may also attract environmentally conscious investors (Dowell and Hart, 2011) [28], which will lead to an increase in share price. The voluntary disclosure of informing that they are engaged in environmental initiatives will improve investment credibility, ultimately reflected in firm value (Matsumura et al., 2014) [14]. Voluntary disclosure signals what they are involved in, such as environmental activities, affects financial performance, and ultimately increases firm value (Al-Tuwaijri et al., 2004; Plumlee et al., 2015) [5,29].

Two opposing theories explain the relationship between disclosing environment information and firm value, the value-added asset theory and the altruistic liability theory. First, value-added asset theory suggests that firms' efforts to solve the environmental issue increase firm value. The theory explains that firms' environment-related efforts will innovate products, comply with upcoming environmental regulations, and signal them as environmentally friendly firms. Thus, disclosing environmental issues will lead to higher firm value. Matsumura et al. (2014) [14] showed the negative relationship between carbon emission levels on firm value, suggesting that the U.S. stock market reflects voluntary disclosure of carbon emission. If the information on carbon emissions impacts positively on the firm's reputation, it is highly likely to increase in sales, securing labor force, and reduce potential litigation costs associated with environmental responsibility

However, altruistic liability theory suggests that firms that emit pollutants are obligated to resolve pollution and investment to address these obligations increases costs. For instance, the investment to achieve environmental performance is viewed as an expense under this theory. Disclosing carbon information increases the firm's risk and leads to a decline in corporate value, if information on carbon emission is regarded as a risk factor. Thus, the firm value will decrease as they disclose their environmental efforts. Due to conflicting theories on the relationship between the voluntary disclosure of carbon emission and firm value, we established the following hypothesis.

**Hypothesis 1 (H1).** *A firm's voluntary disclosure of carbon emission is related to firm value.*

To ensure information relevancy and transparency in the process of management transmitting information, an IC system that has control within firms is necessary. An IC system is defined as the process of providing reasonable assurance for reliable financial reporting (PCAOB 2004) [30]. At the same time, the purpose of the IC system is to publish reliable accounting information (External Audit Act, Article 2-2, Korea). Thus, an effective IC system is expected to yield reliable information (Doyle et al., 2007) [31]. In order to improve the reliability of accounting information, the effective operating of the IC system

is required, which depends on the personnel in charge of the system. For this reason, COSO emphasizes that the investment in sufficient human resources for the IC system is an essential element in carrying out the basic control activities of the IC system (COSO 1992) [7]. Specifically, when sufficient human resource investment in the IC system is carried out, the appropriate segregation of duties to monitor and examine the accounting function is possible (COSO 2006) [18]. Ge and McVay (2005) [21] report that the lack of qualified personnel in an IC system is the frequent reason for reporting material weaknesses of the IC system. They suggest that sufficient qualified personnel is the key to an effective IC system.

In this study, we focus on the effect of the characteristics of IC personnel as measuring the operating effectiveness of IC systems on the value relevance of voluntary disclosure. The characteristics of IC personnel considered in this study are qualitative and quantitative aspects of IC operation, number of IC personnel, and average working experiences in accounting, financing, and IT departments. Having a sufficient number of IC personnel ensures the proper segregation of duties, reviews on a timely basis, and monitoring of accounting functions (Choi et al., 2013) [32]. Additionally, having sufficient personnel in charge or expertise is vital to ensure information is generated by the management on a timely basis. IC personnel with more experience understand the firm's past and current operations (Shin et al., 2017) [33]. Moreover, they are prompt to respond to changes in the firm's internal or external environmental policies with knowledge about the information shared.

When managers decide to disclose information on carbon emissions, the information should be reliable and transparent (Park et al., 2012) [34], affecting the future decisions of stakeholders and helping the market to make a positive assessment of the firm, which can lead to an increase in corporate value. Firms equipped with effective IC system operations are expected to monitor management through the reporting process. The disclosure of information based on good-quality input tends to be more accurate (Feng et al., 2009) [35], which will lead to credible and transparent reporting. Therefore, if the IC system is sufficiently equipped with proper human resources, disclosing engaging environmental initiatives earns credibility that adds to firm value. Thus, we set up our second hypothesis as follows.

**Hypothesis 2 (H2).** *Investment in IC of human resources in each accounting, financing, and IT department positively affects the relationship between the voluntary disclosure of carbon emissions and firm value.*

**Hypothesis (H2-1).** *The number of IC personnel in each accounting, financing, and IT department positively affects the relationship between the voluntary disclosure of carbon emissions and firm value.*

**Hypothesis (H2-2).** *The average working experiences of IC personnel in each accounting, financing, and IT department positively affects the relationship between the voluntary disclosure of carbon emissions and firm value.*

### 3. Research Design and Sample Description

#### 3.1. Measuring IC Operation

The External Audit Act in South Korea requires firms to follow the rules and procedures of the IC system. With audit reports, the operation of the IC system is also submitted. FSS provides the specific guidelines of disclosure and requires firms to provide information at the department level, such as the Audit Committee, the Board of Directors, the Accounting department, the Finance department, the IT department, and other departments. The content of the IC operation report is the total number of personnel, number of IC personnel, number of CPA, and average working experience in months in each department.

Table 1 is an excerpt from the actual IC report from Samsung Electronics in 2020. In this study, we analyzed the IC human resources at the department level. Table 1 confirms that the average working experience is calculated as the sum of the working experience of the IC personnel divided by the number of IC personnel. The Accounting and Finance departments are the final and practical departments that are responsible for the operation. The IT department is expected to have a significant impact on the internet-based environment.

**Table 1.** Human resource investment in IC system.

| Department            | Total | Percentage of CPA in Charge of IC |                   |                   | Average Working Experience in Months |
|-----------------------|-------|-----------------------------------|-------------------|-------------------|--------------------------------------|
|                       |       | Number of IC Personnel (A)        | Number of CPA (B) | Ratio (B/A × 100) |                                      |
| Audit Committee       | 3     | 3                                 | -                 | -                 | 38                                   |
| Board of Directors    | 11    | 11                                |                   |                   | 30                                   |
| Accounting Department | 48    | 33                                | 4                 | 12.1%             | 138                                  |
| Finance Department    | 20    | 20                                | 1                 | 5.0%              | 160                                  |
| IT Department         | 83    | 15                                | -                 | -                 | 237                                  |

Source: Samsung Electronics, DART, South Korea 2020 [36].

### 3.2. Voluntary Disclosure Measured as CDP Response

CDP is an environmental organization founded in December 2020, headquartered in the United Kingdom, and sponsored by 35 financial institutions in Europe. Since then, participating member institutions have steadily increased to 803 global financial institutions with operating assets under USD 100 trillion, and 6300 firms from 91 countries worldwide have participated in CDP. On behalf of financial institutions around the world, CDP requests and collects accurate information on major carbon emissions. Based on the collected information, the firm's short- and long- term management strategies are analyzed and stated in the report. CDP requests information on the level of climate change awareness, climate change prevention measures, and carbon emissions and analyzes environmental risk. Specifically, the survey items include the overall climate change management information, related risks and opportunities, methodology, emission performance, data, energy, and trading. Then, investors make an investment decision based on the CDP report. By participating in CDP, firms can promote awareness of carbon emissions and contribute to reducing carbon emissions. At the same time, by showing investors sustainable management results, it is possible to create a mechanism that can attract global investment. The collected responses of CDP are available via the CDP website.

Since 2008, with cooperation from the Korea Sustainability Investing Forum (KOSIF) and Ernst & Young, CDP has promoted projects targeting Korean firms. Firms are subject to the carbon emission information survey, voluntary responses to the CDP questionnaire are evaluated by the CDP assessment system, then, the final evaluation results are disclosed in the CDP report. CDP reports can be searched on websites such as Bloomberg, Google, and Finance, and Korean reports can be found through the KOSIF website. KOSIF is a non-profit corporation established with the aim of a sustainable society by socially responsible investment. The CDP valuation method is designed to reflect the scientific levels due to the changes in the capital market and environmental issues to show currently sustainable and future continuous improvement.

### 3.3. Research Model

Our first model focuses on the effect of voluntary disclosure on firm value. To assess the first hypothesis, we established a regression model, Equation (1), following Lee and Jeon (2019) [11]. Equation (2) is the modified regression of Equation (1) to test whether human resources in the IC system are effective (Shin et al., 2014) [24]. If the interaction between voluntary disclosure and the human resources of the IC system in each department



is important to firm value,  $\beta_3$  is expected to be positive. The followings are the specified models.

$$\text{TobinQ}_{t+1} = \alpha_1 + \beta_1 \text{Disclosure}_t + \beta_2 \text{Size}_t + \beta_3 \text{Lev}_t + \beta_4 \text{Roa}_t + \beta_5 \text{Da}_t + \beta_6 \text{Growth}_t + \beta_7 \text{Fo}_t + \text{Ind Dummy} + \text{Year Dummy} \quad (1)$$

$$\text{TobinQ}_{t+1} = \alpha_1 + \beta_1 \text{Disclosure}_t + \beta_2 \text{IC} + \beta_3 \text{Disclosure} \times \text{IC} + \beta_4 \text{Size}_t + \beta_5 \text{Lev}_t + \beta_6 \text{Roa}_t + \beta_7 \text{Da}_t + \beta_8 \text{Growth}_t + \beta_9 \text{Fo}_t + \text{Ind Dummy} + \text{Year Dummy} \quad (2)$$

where, TobinQ = (market value of equity + total liability)/book value of equity; Disclosure = if firms voluntarily disclose information of carbon emission is equal to 1, and 0 otherwise; IC (AcctP, AcctW, FinP, FinW, ITP, ITW): AcctP = Number of IC personnel in the accounting department; AcctW = Average working experiences of IC personnel in the accounting department; FinP = Number of IC personnel in the financing department; FinW = Average working experiences of IC personnel in the financing department; ITP = Number of IC personnel in the IT department; ITW = Average working experiences of IC personnel in the IT department; Size = ln (total assets); Lev = total debt/total asset; Roa = net income/total assets; Da = discretionary accruals; Growth = (sales – sales in prior year)/sales in prior year; Fo = percentage of shares held by foreign investors; Ind Dummy = industry dummies; Year Dummy = year dummies.

The variable, Disclosure, measures managers' choice to disclose information on carbon emissions obtained from CDP responses. The information on the voluntary disclosure of carbon emissions is extracted from the CDP Korea report. CDP collects the responses of climate change information and publishes annual result reports for major firms worldwide. Though CDP hands out questionnaires on carbon emissions, responding to those is at a manager's discretion. Thus, whether the managers provide an answer for voluntary disclosure is determined by the managers. In South Korea, the top 250 companies based on market capitalization are selected and surveyed.

Firm value is measured by Tobin's Q. Tobin's Q incorporates firms' activities in the cross-sectional condition of investment (Morck et al., 1988) [37]. In previous studies (Fatemi et al., 2018, Kang and Jin, 2006) [38,39], Tobin's Q has been used as a proxy for representing firm value. Tobin's Q ratio is evaluated as the closest concept to the theoretical economic efficiency concept, including the impact of potential intangible assets as the ratio of total market value divided by the firm's asset. Therefore, using Tobin's Q, which is suitable for measuring firms' economic performance and an economic measure, the sum of the market value of equity capital and liabilities by dividing by the total amount of asset is estimated. The market value is the sum of the common and preferred stocks at the end of each fiscal year and the total liabilities. Total assets are used as book value.

Control variables are included in the model based on prior research. Size is included in the model and is expected to impact whether the firm discloses the relevant information on carbon emission. Roa and Growth are included in the model to control profitability and firm growth, respectively. The percentage of shares held by foreign investors is included to control the firm's ownership structure. Dummy variables for year and industry are included to control the volatility caused by specific economic conditions within a particular year and industry.

### 3.4. Sample Selection

This study aims to measure the effectiveness of IC human resources on the relationship between voluntary disclosure of carbon emission and corporate value. The data are from firms between 2014 and 2019 and obtained from the official database of KIS-Value (equivalent to Compustat in the US). KIS-Value is operated by the NICE information service, the first and largest financial corporation that provides comprehensive financial information about Korean firms. Firms without information on carbon emissions and IC personnel were excluded. The voluntary disclosure information on carbon emissions was

extracted from CDP reports. We hand collected the information about IC personnel, which is available in the FSS [36]. We excluded financial industry and non-December year-end firms for data consistency. The final 734 firms were used in this study. Control variables both 1% at the top and bottom were winsorized to reduce the possible outlier effect. The data selection process is described in Table 2.

**Table 2.** The data selection process.

| Panel A. Sample Selecting Process                                      |     |
|--|-----|
| December year-end CDP response firms with IC system in years 2014–2019 | 995 |
| Less:  |     |
| Financial industry   | 136 |
| No financial data  | 125 |
| Final observation  | 734 |

Table 3 displays the data distribution by Global Industry Classification Standards (GICS) in CDP reporting. GICS classifies all firms into nine industries: Energy, Materials, Industrials, Consumer Staples, Consumer Discretionary, Communication Services, Information technology, and Utilities. Industries of materials and communication services show the highest distribution.

**Table 3.** The data distribution by GICS.

|                                      |     |
|--------------------------------------|-----|
| Energy                               | 93  |
| Materials                            | 129 |
| Industrials                          | 97  |
| Consumer staples                     | 105 |
| Consumer discretionary               | 99  |
| Communication Services               | 127 |
| Information technology and utilities | 84  |
| Total                                | 734 |

## 4. Empirical Results

### 4.1. Descriptive Statistics

Table 4 shows the descriptive statistics of the main variables used in this study. The mean value of firm value (TobinQ) is 1.724. The mean value of voluntary disclosure (Disclosure), measuring whether the firms disclose carbon emission information, is 0.303. The average number of IC personnel in the accounting department (financing department, IT department) is 2.068 (1.315, 1.261). The average working experiences of IC personnel in each accounting, financing, and IT department are 4.031, 3.284, and 3.592, respectively.

Table 5 shows the correlation of the main variables. The correlation between TobinQ and voluntary disclosure is positive and significant. Moreover, the positive correlation between TobinQ and the number of IC personnel in each accounting (AcctP), financing (FinP), and IT (ITP) department is significant, as expected. Additionally, the correlation between TobinQ and the average working experience is positive and significant.

**Table 4.** Descriptive Statistics.

| Variables  | Mean  | STD   | Q1    | Median | Q3    |
|------------|-------|-------|-------|--------|-------|
| TobinQ     | 1.724 | 4.896 | 0.437 | 0.791  | 1.596 |
| Disclosure | 0.303 | 0.460 | 0.000 | 0.000  | 1.000 |
| AcctP      | 2.068 | 1.064 | 1.386 | 2.079  | 2.773 |
| AcctW      | 4.031 | 1.382 | 3.951 | 4.466  | 4.771 |
| FinP       | 1.315 | 1.050 | 0.000 | 1.099  | 2.079 |
| FinW       | 3.284 | 2.017 | 0.000 | 4.248  | 4.787 |
| ITP        | 1.261 | 1.047 | 0.693 | 1.099  | 1.946 |
| ITW        | 3.592 | 1.941 | 3.178 | 4.443  | 4.949 |

Notes: Variable definition: TobinQ = (market value of equity + total liability)/beginning book value of equity; Disclosure = if firms voluntarily disclose the information of carbon emission is equal to 1, and 0 otherwise; AcctP = Number of IC personnel in the accounting department; AcctW = Average working experiences of IC personnel in the accounting department; FinP = Number of IC personnel in the financing department; FinW = Average working experiences of IC personnel in the financing department; ITP = Number of IC personnel in the IT department; ITW = Average working experiences of IC personnel in the IT department.

**Table 5.** Pearson Correlation.

|                | (1)   | (2)             | (3)              | (4)              | (5)              | (6)              | (7)              | (8)              |
|----------------|-------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|
| (1) TobinQ     | 1.000 | −0.107<br>0.003 | −0.131<br>0.000  | −0.016<br>0.661  | −0.096<br>0.008  | 0.004<br>0.907   | −0.110<br>0.003  | −0.036<br>0.319  |
| (2) Disclosure |       | 1.000           | 0.316<br><0.0001 | 0.024<br>0.449   | 0.244<br><0.0001 | 0.042<br>0.182   | 0.262<br><0.0001 | 0.070<br>0.027   |
| (3) AcctP      |       |                 | 1.000            | 0.517<br><0.0001 | 0.550<br><0.0001 | 0.217<br><0.0001 | 0.532<br><0.0001 | 0.279<br><0.0001 |
| (4) AcctW      |       |                 |                  | 1.000            | 0.280<br><.0001  | 0.457<br><0.0001 | 0.281<br><0.0001 | 0.480<br><0.0001 |
| (5) FinP       |       |                 |                  |                  | 1.000            | 0.688<br><0.0001 | 0.598<br><0.0001 | 0.380<br><0.0001 |
| (6) FinW       |       |                 |                  |                  |                  | 1.000            | 0.347<br><0.0001 | 0.537<br><0.0001 |
| (7) ITP        |       |                 |                  |                  |                  |                  | 1.000            | 0.595<br><0.0001 |
| (8) ITW        |       |                 |                  |                  |                  |                  |                  | 1.000            |

#### 4.2. Regression Results and Discussion

Table 6 describes the result of the relationship between the voluntary disclosure of carbon emissions and firm value. The coefficient of disclosure is 0.953 and significantly positive, supporting the first hypothesis. Disclosure generally reduces the information asymmetry between management and investors and promotes efficient distribution (Healy and Palepu 2001) [2]. By voluntarily disclosing reliable carbon emission information, firms provide the market with information on the potential costs of carbon emissions (Armstrong et al., 2010) [40]. This can increase firm value by reducing the uncertainty of future cash flow and reducing the cost of raising capital.

The result is consistent with the previous studies and we interpret the result as follows. Providing and disclosing information on carbon emissions through CDP reporting is not mandatory, but the information on carbon emissions disclosed on the CDP report is considered reliable (Matsumura et al., 2014) [14]. The CDP conducts a survey of major firms worldwide, and emissions are legally regulated for firms belonging to particular countries, such as in the E.U., where the accuracy of carbon emission information is ensured. Thus, the firms that voluntarily disclose information also use this as a guideline to achieve reliability.

**Table 6.** The regression result on the relationship between the voluntary disclosure of carbon emission and firm value.

| Variables           | Coeff. | T-Stat.     |
|---------------------|--------|-------------|
| Intercept           | 48.609 | 10.820 ***  |
| Disclosure          | 0.953  | 2.250 **    |
| Size                | −1.659 | −10.190 *** |
| Lev                 | −0.114 | −0.820      |
| Roa                 | −6.896 | −3.280 ***  |
| Da                  | 3.115  | 1.720 *     |
| Growth              | 0.452  | 1.570       |
| Foreign             | 3.707  | 2.900 ***   |
| Ind Dummy           |        | Included    |
| Year Dummy          |        | Included    |
| F-value             |        | 10.55 ***   |
| Adj. R <sup>2</sup> |        | 0.145       |
| Observations        |        | 734         |

\*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

The greater stakeholders' interest in climate change, requesting certainty of carbon emission information (Kleimerire and Vieh, 2016) [41], the more accurate and reliable the information is confirmed in the market (Choi and Noh 2016) [15]. Alternatively, if the firm reports unreliable information in the future and is known to the market, the firm can lose credibility in its information disclosure about carbon emissions and even other kinds of information. Moreover, the firm may face the risk of litigation. Therefore, the firm's information reported to CDP, though voluntary, will have high credibility. The firm's efforts to reduce carbon emission positively impact the firm's reputation, increase sales, secure a good workforce, and reduce potential environmental costs, thereby increasing the possibility of generating economic benefits.

Table 7 shows the results of multiple regression analysis for hypothesis 2. Panel A and B show the characteristics of IC human resources. Panel A shows the effectiveness of the number of IC personnel of the accounting (AcctP), financing (FinP) and IT (ITP) departments on the relationship between voluntary disclosure of carbon emissions and firm value. The coefficients of interaction terms, Disclosure X AcctP, Disclosure X FinP, and Disclosure X ITP are positive and significant at the 5% level. This result implies that more IC personnel in each accounting, financing, and IT department positively affects the relationship between voluntary disclosure and firm value. Thus, the result of Table 7 supports the second hypothesis.

Panel B displays the effectiveness of working experiences on the relationship between voluntary disclosure and firm value. The coefficients of interaction terms, Disclosure X AcctW and Disclosure X FinW, are positive and significant. This result implies that the average working experience of IC personnel plays a positive role in the relationship between the voluntary disclosure of carbon emission and firm value.

Voluntary disclosure is the process of passing private information to another, and its content may be informational or indiscriminate. In the study of Feng et al., (2009) [35], managers' voluntary disclosure is considered informative disclosure. However, the quality of voluntary disclosure will be less accurate based on poor quality input, such as the opinion of material weakness. If firms have material weaknesses, they are highly likely to be designated as unfaithful disclosure firms (Sohn et al., 2005) [42]. Current and potential investors need to ensure that the information available to the firm is relevant. Ge and McVay (2005) [21] suggested that the effectiveness of the IC system depends on the IC operating components, such as sufficient staff and adequate training, leading to the credibility of voluntary disclosures. As Botosan et al. (2004) [43] argue, disclosure is better off with good corporate governance. In a similar vein, firms with sufficient IC human resources

create credible information that they are engaged in environmentally-concerned initiatives, ultimately leading to positive firm valuation.

**Table 7.** The effect of IC operation on the relationship between the voluntary disclosure of carbon emission and firm value.

| Panel A. Number of IC Personnel       |            |             |            |            |            |            |
|---------------------------------------|------------|-------------|------------|------------|------------|------------|
| Variables                             | Accounting |             | Financing  |            | IT         |            |
|                                       | Department |             | Department |            | Department |            |
|                                       | Coeff.     | T-Stat.     | Coeff.     | T-Stat.    | Coeff.     | T-Stat.    |
| Intercept                             | 47.536     | 10.220 ***  | 68.151     | 11.430 *** | 49.175 *** | 10.990     |
| Disclosure                            | −0.732     | −0.750      | −0.249     | −0.260     | 0.147      | 0.270      |
| AcctP                                 | −0.087     | −0.350      |            |            |            |            |
| Disclosure X AcctP                    | 0.722      | 1.980 **    |            |            |            |            |
| FinP                                  |            |             | −0.007     | −0.020     |            |            |
| Disclosure X FinP                     |            |             | 0.983      | 2.090 **   |            |            |
| ITP                                   |            |             |            |            | −0.278     | −1.270     |
| Disclosure X ITP                      |            |             |            |            | 0.615 **   | 2.040      |
| Size                                  | −1.407     | −7.970 ***  | −2.178     | −9.980 *** | −1.540 *** | −9.480     |
| Lev                                   | −0.103     | −0.750      | 0.175      | 1.140      | −0.058     | −0.430     |
| Roa                                   | −5.957     | −2.960 ***  | −0.809     | −0.280     | −7.511 *** | −3.480     |
| Da                                    | 3.250      | 1.870 *     | −0.956     | −0.340     | 6.261 ***  | 2.960      |
| Growth                                | −4.352     | −5.600 ***  | 0.624      | 1.510      | −4.462 *** | −5.580     |
| Fo                                    | 3.647      | 2.800 ***   | 4.484      | 2.770 ***  | 3.261 ***  | 2.660      |
| Ind Dummy                             |            | Included    |            | Included   |            | Included   |
| Year Dummy                            |            | Included    |            | Included   |            | Included   |
| F-value                               |            | 10.710 ***  |            | 10.480 *** |            | 22.430 *** |
| Adj. R <sup>2</sup>                   |            | 0.241       |            | 0.219      |            | 0.247      |
| Observations                          |            | 734         |            | 734        |            | 734        |
| Panel B. Working Experience in Months |            |             |            |            |            |            |
| Intercept                             | 44.596     | 11.890 ***  | 54.073     | 9.880 ***  | 52.790     | 10.180 *** |
| Disclosure                            | −2.645     | −1.610      | −2.571     | −1.360     | −2.657     | −1.530     |
| AcctW                                 | 0.034      | 0.220       |            |            |            |            |
| Disclosure X AcctW                    | 0.520      | 2.160 **    |            |            |            |            |
| FinW                                  |            |             | −1.266     | −1.410     |            |            |
| Disclosure X FinW                     |            |             | 0.638      | 2.130 ***  |            |            |
| ITW                                   |            |             |            |            | −0.210     | −1.070     |
| Disclosure X ITW                      |            |             |            |            | 0.577      | 2.070 **   |
| Size                                  | −1.386     | −10.160 *** | −1.637     | −8.240 *** | −1.619     | −8.510 *** |
| Lev                                   | 0.033      | 0.310       | −3.682     | −2.850 *** | −0.001     | 0.000      |
| Roa                                   | −2.206     | −1.910 *    | −6.580     | −2.450 **  | −5.093     | −2.040 **  |
| Da                                    | 2.936      | 1.640 *     | 1.013      | 0.350      | 2.713      | 1.030      |
| Growth                                | −3.034     | −4.320 ***  | −4.188     | −4.440 *** | −4.024     | −4.440 *** |
| Fo                                    | 2.630      | 2.480 **    | 2.166      | 1.420      | 4.099      | 2.680 ***  |
| Ind Dummy                             |            | Included    |            | Included   |            | Included   |
| Year Dummy                            |            | Included    |            | Included   |            | Included   |
| F-value                               |            | 10.480 ***  |            | 8.820 ***  |            | 8.050 ***  |
| Adj. R <sup>2</sup>                   |            | 0.219       |            | 0.241      |            | 0.327      |
| Observations                          |            | 734         |            | 734        |            | 734        |

\*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

#### 4.3. Additional Analysis

Table 8 shows the relationship between the disclosure of the firms' perception of climate change, DAM, and firm value. The coefficient of DAM is 0.551, and positively significant at the 1% level. The variable DAM represents the disclosure of the firms' awareness on climate change based on the CDP assessment method. DAM is categorized into three types; Disclosure, Awareness, and Management (DAM) (Kang et al., 2018) [44]. D is an acronym of the Disclosure stage. In this stage, the awareness of climate change

risks and opportunities has begun. It is the starting of awareness of the potential impact of climate change on the overall management activities. The second stage is the Awareness stage (A). In this stage, firms recognize the impacts of climate change, the need to measure related issues, risks, and business impacts, and put them into action and practice. The third is the Management stage (M). In this stage, firms understand climate change management and expand coordination of internal management activities for preemptive responses.

**Table 8.** The relationship between DAM and firm value.

| Variables           | Coeff. | T-Stat.    |
|---------------------|--------|------------|
| Intercept           | 60.747 | 10.930 *** |
| DAM                 | 0.551  | 2.730 ***  |
| Control Variables   |        | Included   |
| Ind Dummy           |        | Included   |
| Year Dummy          |        | Included   |
| F-value             |        | 11.16 ***  |
| Adj. R <sup>2</sup> |        | 0.281      |
| Observations        |        | 734        |

\*\*\* indicate significance at the 1% levels.

Our result is in line with the study of Kang et al. (2018) [44], which reports the correlation between carbon reduction and each stage. In our study, we regressed the effect of DAM on firm value. The result suggests that as the firms disclosing their perception of climate change moves from D to M, the firm value increases. This implies that firms recognizing the risk factors for climate change and applying them to their management are higher in firm value than those merely disclosing information on climate change.

Recent studies have cited climate change's uncertainty as one of the biggest challenges that Korean firms face. This could be a cause of firms recognizing the risks of climate change and not even taking action (Kang et al., 2018) [44]. As climate change issues are characterized by uncertainty, a consistent and long-term tone of government is needed. Government policymakers need to consider the characteristics of corporate perceptions and behaviors in carbon emission reduction and climate change policy. In addition, efforts are required to strengthen the incentive system that allows firms to promote voluntary responses with positive and strategic awareness. For instance, it is necessary to develop a policy centered on the firms that are highly aware of risk and opportunity factors and have a positive awareness, rather than firms that are negative and dismissive about climate change. Doing so may motivate passive firms about climate change and lead to proper education and training to support perception changes. After all this effort, if the perception elevates to a higher level, the firm value may increase.

Table 9 displays the result on the ESG effect on the relationship between voluntary disclosure and firm value. The coefficient of the interaction term (Disclosure X ESG) is 1.811 and significant at 5%. Firms participating in ESG imply that the firms care about economic, social, and environmental sustainability. Firms that report good ESG scores generate a favorable reputation and report a higher firm value (Cahan et al., 2015; Fatemi et al., 2018) [38,45].

**Table 9.** Effect of ESG on the association between the voluntary disclosure and firm value.

| Variables           | Coeff. | T-Stat.    |
|---------------------|--------|------------|
| Intercept           | 50.519 | 10.290 *** |
| Disclosure          | −0.345 | −0.490     |
| ESG                 | −0.021 | −0.040     |
| Disclosure × ESG    | 1.811  | 2.190 **   |
| Control Variables   |        | Included   |
| IND Dummy           |        | Included   |
| YEAR Dummy          |        | Included   |
| F-value             |        | 9.28 ***   |
| Adj. R <sup>2</sup> |        | 0.205      |
| Observations        |        | 734        |

\*\* and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

According to stakeholder theory (Freeman 1984) [46], socially responsible behavior generates the opportunity for greater growth and risk reduction to meet the interest of debtors, employees, and customers. In particular ESG, a prolongation of socially responsible behavior, involves efficient processes, energy consumption reduction (Fatemi et al., 2018) [38], and effectiveness in the environment-related industries (Qureshi et al., 2019) [47]. Firms may emphasize their ESG disclosure to prevent the negative consequences of severe environmental damages on their market value (Fatemi et al., 2018, Cho and Patten 2007) [38,48]. In addition, firms with high ESG scores are expected to be long-term oriented, highly sustainable, and have better disclosure practices (Eccles et al., 2014) [49]. A high score in ESG will attempt to build a reputation for anchoring competitiveness in the market with a transparent managing environment. This behavior will enhance stock prices and reduce uncertainty and risk in the market. This result confirms that ESG's role in the relationship between voluntary disclosure and firm value is positively compelling.

## 5. Conclusions

Climate change is a risk factor that threatens all humankind. Many countries have already experienced enormous damages due to extreme weather changes caused by climate change, which significantly impact business activities. Climate change is an important factor acting as an essential variable in the ecosystem, living environment, and economic growth. Corporate responses to climate change go beyond choice and reflect consumer needs and trends, and corporate obligation. During these changes, if a firm recognizes the risks of climate change and actively implements activities as a response, the firm's response to climate change will not be restrictive but will provide the opportunity to create value. Using 734 firms with their carbon emission information, we found a positive effect of voluntary disclosure on firm value, supported by the value-added theory. Efforts to overcome the risks lead to innovative product investments, complying with environmental regulations, and signals firms as eco-friendly, all of which result in higher firm value. Additionally, voluntary disclosure on carbon emissions will attract investors, leading to lower capital costs and firm value. Moreover, we examined the operating effectiveness of the IC system on a qualitative and quantitative level. Specifically, a sufficient number of IC personnel and having more average working experience leads to better input and assists the relationship between voluntary disclosure and firm value. In our additional test, we tested the level of environmental awareness on firm value. As firms recognize the environment with a higher awareness, they are likely to consider environmental risk. The analysis result indicates that the firms that recognize the more evident factors rather than just providing simple information disclosure are connected to the systematic management of dealing with a high level of carbon emissions. We found a positive effect of ESG on the relationship between voluntary disclosure and firm value. Firms with a high score of ESG are expected to have a superior management environment and better disclosure practices.

Therefore, the role of ESG positively affects the relationship between voluntary disclosure and firm value.

The findings of this study have meaningful implications. It is the first study to examine the effectiveness of the IC system focusing on the human resource from qualitative and quantitative perspectives. If a firm wants to establish a robust IC system, it can hire more IC personnel or expertise. In addition, this study contributes by adding to the empirical evidence of research in the voluntary disclosure area that disclosing negative information can also provide usefulness to market participants. It is expected that a comprehensive examination of the response rate and evaluation results of the recent CDP will be useful for the development of research related to climate change in the future.

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