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The Impact of Carbon Emissions on Corporate Cost of Debt (COD): A Research on Borsa İstanbul (BIST) Sustainability Index

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Karbon Emisyonlarının Şirketlerin Borçlanma Maliyeti Üzerine Etkisi: BİST Sürdürülebilirlik Endeksinde Bir Araştırma

Abstract

This study examines the influence of carbon emissions of companies traded on the BIST Sustainability Index on the cost of debt for 2017-2021. In other words, the study aims to guide decision-makers towards carbon emissions reduction by showing a significant impact between the cost of debt and carbon emissions. The data were obtained from the Public Disclosure Platform, companies' financial statements, annual reports, sustainability reports, integrated reports, and the DataStream database and were subjected to statistical analysis. Panel data pooled OLS method was used in the study. The study found a significant impact of total carbon emissions, carbon emission intensity, leverage, and structure variables on the cost of debt. However, it was concluded that the size, return on assets, growth, and cash flow variables did not significantly impact the cost of debt.

Keywords : Cost of Debt, Carbon Emissions, Sustainability, Panel Data Analysis.

JEL Classification Codes : M40, M41, Q56.

Öz

Bu çalışmanın amacı, 2017-2021 yılları için BİST Sürdürülebilirlik Endeksinde işlem gören şirketlerin karbon emisyonlarının borçlanma maliyeti üzerindeki etkisini incelemektir. Bir başka ifade ile borçlanma maliyeti ile karbon emisyonu arasında anlamlı bir etki olduğunu göstermek suretiyle karar alıcıları, karbon emisyonu azaltımına yöneltmektir. Çalışmada veriler Kamuyu Aydınlatma Platformundan (KAP), şirketlerin finansal tablo dipnot ve açıklamaları, faaliyet raporları ile sürdürülebilirlik raporları, entegre raporları ve DataStream veri tabanından elde edilerek istatiksel analize tabi tutulmuştur. Çalışmada panel veri havuzlanmış EKK yöntemi kullanılmıştır. Çalışma sonunda toplam karbon emisyonu, karbon emisyon yoğunluğu, kaldıraç ve yapı değişkenlerinin borçlanma maliyeti üzerine anlamlı bir etkisinin bulunduğu tespit edilmiştir. Ancak büyüklük, aktif kârlılık, büyüme ve nakit akışı değişkenlerinin borçlanma maliyeti üzerinde anlamlı bir etkisinin bulunmadığı sonucuna varılmıştır.

Anahtar Sözcükler : Borçlanma Maliyeti, Karbon Emisyonları, Sürdürülebilirlik, Panel Veri Analizi.

1. Introduction

It is possible to mention the many adverse effects of global warming and climate change that threaten sustainable development (SD). Initially, the concept of SD, which was put forward for continuous economic growth and protection and development of the environment, was expanded to include social and economic perspectives alongside environmental concerns (Gedik, 2020: 1). No widely accepted description of SD exists in the literature. However, the definition put forward by the Brundtland Commission[1], "The ability of humanity to SD, that is, to meet the needs of the present without compromising the ability of future generations to meet their own needs," can be considered the most standard and accepted definition (Kates et al., 2005: 10).

The most crucial factor leading to climate change and global warming is greenhouse gas (GHG) emissions. GHGs consist of gases such as carbon dioxide (CO_2), ozone (O_3), nitrous oxide (N_2O), water vapour (H_2O), methane (CH_4), and gas compounds such as perfluorocarbon (PFC), hydrofluorocarbon (HFC), and sulphur hexafluoride (SF_6) that are formed during industrial production processes. Carbon emissions (CE) have a significant share among these GHG emissions. CO_2 gas accounts for approximately 80% of the total GHG emissions (Demirtürk, 2021: 1082).

For a long time, governments and regulatory authorities have been implementing many regulations and taking some measures to combat the GHG effect and climate change. The UN's Framework Convention on Climate Change (UNFCCC) was signed in 1992 at the Rio Conference on Environment and Development with the participation of many countries (Sultanoğlu & Özerhan, 2020: 177-178). The Kyoto Protocol was signed in 1997 under the UNFCCC, which aims to reduce CE (Güneysu & Atasel, 2022: 1184). The protocol imposed internationally binding emission reduction targets on the parties and was enacted in 2005. The parties to the UNFCCC accepted the Paris Climate Agreement in 2015. According to the agreement, CE expressed as Scopes 1, 2, and 3 must be reduced to deficient levels (Sultanoğlu & Özerhan, 2020: 178). Türkiye officially became a party to the UNFCCC on May 24, 2004, and to the protocol on August 26, 2009. Nonetheless, Türkiye signed the Paris Agreement on April 22, 2016, and the law on its acceptance was enacted on October 7, 2021 (Güneysu & Atasel, 2022: 1184).

As a result of these regulations, companies should disclose what measures they have taken to reduce CE and the trend of their CE over the years through sustainability reports and Carbon Disclosure Project (CDP) reports for internal and external stakeholders. The amount of CE by companies affects their financial status, carbon risk, and cost of debt (COD), and hence their sustainability.

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[1] *World Commission on Environment and Development (WCDE), which was established in 1983 as a subsidiary of the United Nations with the purpose of "recommending long-term environmental strategies to achieve sustainable development until 2000 and beyond" with the UN General Assembly Resolution is also known as Gro Harlem Brundtland, Norwegian Prime Minister Former Head of the Commission.*

Caragnano et al. (2020: 2) stated that corporate lenders, credit rating agencies, and institutional investors included carbon risk assessments in their credit risk evaluation processes with the implementation of strict environmental regulations and policies, particularly for medium and large companies operating in environmentally friendly sectors. Additionally, the study highlighted that with the increasing global interest in reducing GHG emissions and regulations aimed at reducing environmental issues, cash flows can be affected significantly, and current costs and potential future damages can increase, particularly for companies that pollute the environment more. It was also emphasised that lenders and credit institutions that finance environmentally irresponsible companies may be at risk of damaging their reputation and long-term capability of retaining existing customers and attracting new ones, as well as their future operations and competitive position. Therefore, companies with higher levels of CE were expected to incur higher costs to finance their operations than companies that pollute the environment less.

In some studies in the literature (Spicer, 1978; Mahapatra, 1984; Klassen & McLaughlin, 1996; Russo & Fouts, 1997; Montabon et al., 2007; Russo & Pogutz, 2009), there is a prevailing view that a positive association exists between environmental and economic performances (Caragnano et al., 2020: 2).

In their study, Li et al. (2014) attracted attention to three factors to justify the association between COD and carbon risk. Firstly, rating agencies such as S&P may reduce the borrowing amount of certain enterprises due to concerns about GHGs, which can increase the credit default risk premium for these companies. Secondly, companies with high carbon risk (carbon emission intensity - CEI) may have a higher risk of violating loan contracts because carbon costs can reduce the diversity of assets held by creditors. This means that companies with many carbon-intensive assets may need to sell these assets to increase their borrowing capacity, thereby reducing the diversity of their assets. The Carbon Pollution Reduction Scheme (CPRS), which was repealed in 2009, argues in its criticism that lenders may avoid lending to companies with high carbon costs because high-emission assets are considered riskier. Therefore, lenders may want to impose stricter terms and higher costs on loans to companies with high CE to secure their loans. Finally, companies with high CE may face financial problems if the costs of litigation and CE reduction increase, which can reduce the financial resources available to pay back debts. This study suggests that COD increases as companies' CE increases.

In a study conducted by Jung et al. (2018), it was noted that lending institutions take CEI into account during their general risk assessments, and they may repeat loan agreement terms related to collateral, loan maturity, and loan cost to reduce the influence of CEI on borrowers (enterprises). Additionally, they stated that CODs are lower for environmentally conscious companies with low CEI and high carbon awareness, which enables them to borrow at lower rates.

In studies focusing on the influence of GHGs on the environment and detail examined in the literature review, a positive association between COD and GHGs was found. In other

words, companies with high GHG emissions were found to have higher COD. However, studies have also reported that environmentally conscious companies that reduce carbon risk and have heightened awareness for reducing carbon have lower COD. This research aims to investigate the influence of CE on COD in Türkiye, determine whether companies can reduce their COD by reducing their CE, and encourage companies to reduce their CE.

Various studies[2] have been carried out on CE in the literature, such as carbon cost and management accounting, CE accounting, carbon disclosures, carbon reporting, GHG emission accounting and reporting, GHG disclosures and assurance, carbon footprint reporting, and carbon transparency project disclosures. Even though studies[3] exist in the international literature examining the influence of CE on COD, no study investigating the effect of CE on COD has been found in Türkiye. To contribute to the field, this research examines the impact of CE of companies traded on the BIST Sustainability Index (SI) on COD. In this context, data on the CE and COD of 38 out of 65 companies traded on the BIST-SI, which published sustainability or integrated reports in 2021, were obtained from the Public Disclosure Platform (PDP), companies' financial statement footnotes and disclosures, annual reports, sustainability reports, integrated reports, and the DataStream database. The data were then subjected to statistical analysis using the STATA package software, and the effect of CE on COD was investigated.

In the study, the literature on the effect of CE on COD was first reviewed, the variables were explained with the dataset, and then the developed hypotheses, research method, and findings were presented. Finally, the findings were discussed in the conclusion section, and recommendations were given.

2. Literature Review

Based on the literature review, it is noticed that various studies have been carried out on CE, including carbon accounting, GHG emission accounting and reporting, reporting of carbon footprints, disclosure of GHG emissions, assurance of emissions, carbon transparency project disclosures, and CE disclosures. While studies on the impact of CE on COD have been conducted in some countries (such as European countries, the USA, Australia, Canada, India, the UK, and China), at the time of this study, no direct research has been found in Türkiye examining the impact of CE on COD. In this context, the findings

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[2] *Kardeş Selimoğlu et al. (2022); Kızıltan and Doğan (2021); Demircioğlu and Ever (2020); Aliusta and Yılmaz (2020); Öktem (2020); Sultanoğlu and Özerhan (2020); Çokmutlu and Ok (2019); Güleç and Bektaş (2019); Qian et al. (2018); Altınbay and Golagan (2016); Gonzalez and Ramirez (2016); Chithambo and Tauringana (2014); Choi et al. (2013); Zhang et al. (2013); Tsai et al. (2012); Hrasky (2012); Luo et al. (2012); Solomon et al. (2011); Burritt et al. (2011); Ratnatunga and Balachandran (2009); Stanny and Ely (2008); Simnett and Nugent (2007).*

[3] *Analysed in detail in the literature review section [Panjwani et al. (2022); Kozak (2021); Vullings (2021); Caragnano et al. (2020); Palea and Drogo (2020); Pizzutilo et al. (2020); Wang et al. (2020); Jung et al. (2018); Maaloul (2018); Kumar and Firoz (2018); Kleimeier and Viehs (2018); Zhou et al. (2017)] by studies.*

of studies covering some countries outside of Türkiye on the effects of CE on COD are as follows:

Panjwani et al. (2022) examined the impact of Scope 3 CE disclosure on firms' COD. The study analysed panel data from 2720 companies in the MSCI All Country World Index for 2015-2020. The study found that companies that disclose their Scope 3 emissions have lower COD.

Kozak (2021) examined the relationship between CEI and COD for 255 large-scale non-financial companies in 15 EU countries between 2018 and 2021. The study, which used fractional logit regression analysis, detected a significant association between CEI and COD, with low CEI firms having lower COD.

Vullings (2021) examined the impact of CEI on COD for 2737 firms operating in the US and Europe between 2013 and 2019 and the mitigating role of carbon policy in the US and Europe. The study used multiple regression analysis and found a significantly positive effect of CEI on COD.

Caragnano et al. (2020) investigated the effect of GHGs on COD for EuroStoxx 600 firms. The study analysed panel data from 592 firms from 2010-2017. A positive association existed between CEI and COD. The study also found that firms with high CEI have higher COD. The study also concluded that control variables (profitability, size, leverage, and cash flow) positively correlate with COD.

Palea and Drogo (2020) examined the relationship between CE and COD for companies in the European region from 2010 to 2018. The OLS analysis was conducted to estimate the effect of CEI on COD. The study found a positive association between CE and COD, and COD increased as CE increased.

Pizzutilo et al. (2020) investigated the relationship between CEI and COD of EuroStoxx 600 companies. The data of 616 companies from 2010-2017 were analysed using panel data analysis. In the study, the data relevant to the COD were obtained from the Bloomberg Data Service. A positive association existed between CEI and COD. The study concluded that companies with high CEI and, therefore, high CEI had higher COD. In this respect, it was stated that companies with high carbon risk due to carbon intensity had high COD.

In Wang et al. (2020) study, the relationship between corporate CE and COD of 112 companies operating in the global tourism industry was examined for the period between 2003 and 2016. Data for the study was obtained from Thomson Reuters, DataStream, and Worldscope databases. Panel data analysis, correlation, and regression analysis were conducted in the study, and a positive association existed between CE and COD. The companies with high CE had higher COD.

Jung et al. (2018) examined the impact of CEI and CEI awareness on the COD of 255 companies listed on the ASX between 2009 and 2013. The study used panel regression analysis. The study found that companies with high carbon awareness were more inclined to answer the CDP survey and more likely to manage CEI. Additionally, companies with high CEI were found to have higher CEI, which positively affected their COD.

Maaloul (2018) examined the effect of GHG emissions on the COD of 318 companies listed on the S&P/TSX in Canada between 2012 and 2015. Data on GHGs were obtained from CDP reports, while COD and other financial information were accepted from the Bloomberg Professional Data Service. The study used correlation and regression analysis and found a positive association between COD and GHGs. The study also identified that control variables (size, profitability, leverage, market/book ratio, and volatility) positively correlated with COD.

Kumar and Firoz (2018) examined the impact of CE on the COD of 46 manufacturing and service sector companies in India between 2011-2014. The study used panel data analysis and found a significant effect of CE on COD.

Kleimeier and Viehs (2018) investigated the effect of voluntary carbon emission disclosure (CED) by publicly traded companies in the UK FTSE 500 on their COD from 2007 to 2013. The study used panel regression analysis and detected a negative relationship between voluntary CED and COD.

Zhou et al. (2017) studied the association between CEI and COD for 191 Chinese firms in high-carbon industries between 2011 and 2015. The study also examined the media's regulatory role. The study used panel regression analysis and detected a U-shaped association between CEI and COD. The study identified corporate governance and ownership structure as media intermediaries and suggested that positive media effects of corporate governance could reduce the relationship between CEI and COD.

A positive relationship between CE and COD can be observed when the literature above is evaluated to examine the effect of carbon emissions on COD. Findings from these studies "Caragnano et al. (2020); Palea and Drogo (2020); Pizzutilo et al. (2020); Wang et al. (2020); Jung et al. (2018); Maaloul (2018)" indicate that companies with higher CEI also have higher COD.

3. Research on the Impact of CE on COD of Companies Listed in BIST-SI

3.1. Aim and Significance of the Study

This study aims to investigate the impact of CE on the COD of companies listed in the BIST-SI on a company-specific basis. To this end, the study examines the association between total CE and CEI as independent variables and control variables such as size, return on assets (ROA), leverage, growth, structure, and cash flow on COD. The data used in the

study is collected from 38 companies[4] listed in the BIST-SI. This study is considered a pioneering work in Türkiye, presenting findings that support a positive association between CE and COD. It is crucial for providing insights on Turkish companies, motivating them to take measures to reduce CE, and contributing to the literature.

3.2. Scope and Limitations of the Study

This research examines the data of the companies listed in the BIST-SI. The sustainability reports published by the companies in the BIST-SI were reviewed over the years. It was noticed that the years with the highest number of sustainability reports published were between 2017-2021. Therefore, the sustainability reports and data of the companies between 2017-2021 were analysed. During the research in October 2022, 65 companies were listed in the BIST-SI. It was found that 38 companies had published their sustainability or integrated reports for 2021. This limited number of companies is also a constraint of the study.

3.3. Dataset and Variables of the Study

The study dataset consists of the 2017-2021 data of 38 companies listed on the BIST-SI. The data for the companies were obtained from the PDP in October 2022, official activity reports, footnotes and disclosures, sustainability reports, integrated reports, and the DataStream database published on the companies' official websites.

Table: 1
Research Variables and Their Definitions

Abbreviations of the Variables	Names of the Variables
Ln Cod*	COD: Ln (Interest Expense / Total Debt Related to Interest Expense)
Ln Total CE**	Total CE*** The logarithm of (the total amount of Scope 1 and 2 or Scope 3 GHGs in metric tons)
TS	Total Sales
Carbon Emissions Intensity (%)	CEI**** = Total CE / Total Sales
TA	Total Assets
NP	Net Profit
ROA (%)	Return on Assets = Net Profit / Total Assets
SIZE***	ln (Total Assets)
TD	Total Debts
LEVERAGE (%)	Total Debts / Total Assets
MV	Market Value
BV	Book Value
GROWTH (%)	Market Value / Book Value
STRUCTURE (%)	Tangible Fixed Assets /Total Assets
CASH FLOW (%)	Cash Flow = Net Cash Flow /Total Assets

** In this study, finance expense corresponding to the research period was used as the variable for the cost of debt, and its logarithm was calculated to ensure linearity.*

*** The total CE variable was taken as the total amount of Scope 1 and 2 or Scope 3 GHGs in metric tons, and its logarithm was calculated to ensure linearity.*

**** Scope 1 and 2 are emissions owned or controlled by a company. Scope 3 emissions, however, result from a company's activities but come from sources not owned or controlled. In other words, Scope 1 is what you burn, Scope 2 is what you buy, and Scope 3 is everything beyond that <https://www.zorlu.com.tr/akillihayat2030/yazilar/kapsam-1-2-3-ne-anlama-geliyor>, 01.12.2022.*

***** Carbon emission intensity indicates a company's carbon risk and is calculated by dividing total carbon emissions by total sales. Similar calculations of carbon emission intensity have been used in the literature by Zhou et al. (2017), Maaloul (2018), Jung et al. (2018), Palea and Drogo (2020), and Vullings (2021).*

****** This study used Total Assets as the size variable, and its logarithm was calculated to ensure linearity.*

[4] *Information about the companies is presented in Appendix 1.*

In the study, the dependent variable of COD was taken to examine the impact of CE on COD. COD can be expressed as finance expenses incurred during the research period. Information related to the COD variable was obtained from the DataStream database. The logarithm of the received data was included in the analysis to ensure linearity.

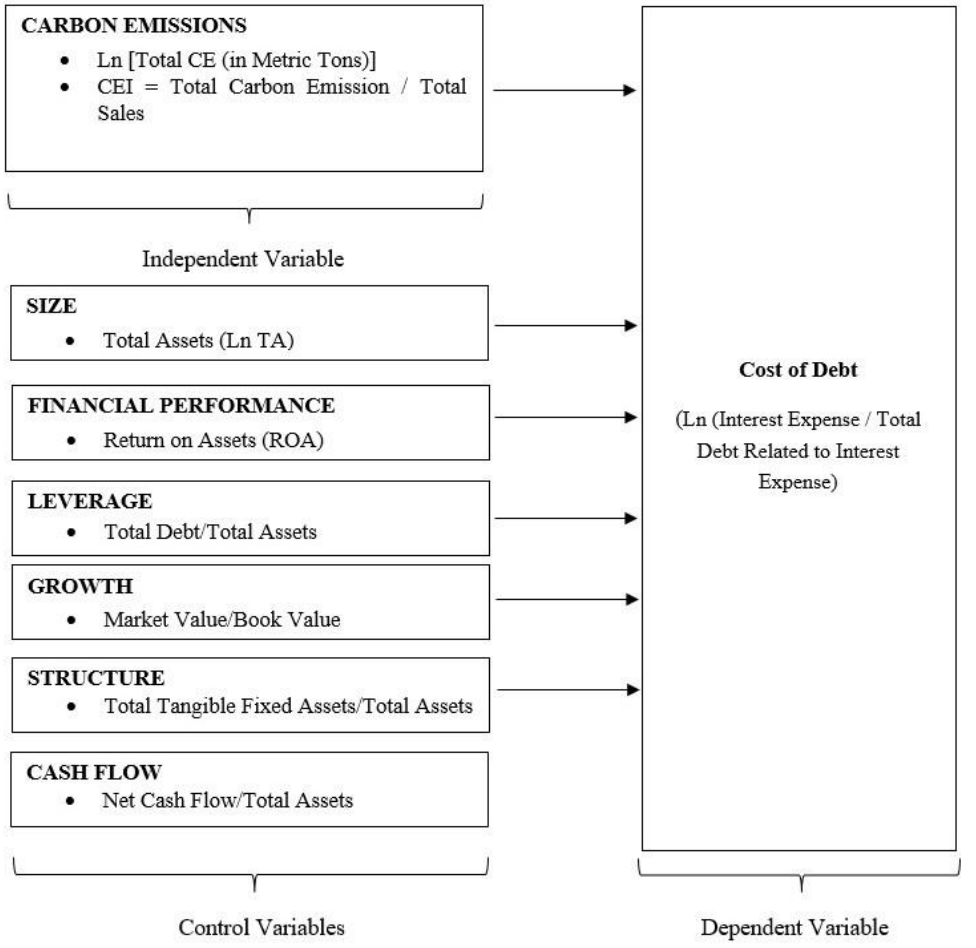
CE were taken as independent variables in the study, and Total CE and CEI variables were used to examine the relationship between CE and COD. The calculation of these variables is given in Table 1, and information related to these variables was obtained from the companies' annual reports and sustainability reports.

Previous studies such as Vullings (2021); Caragnano et al. (2020); Pizzutilo et al. (2020); Wang et al. (2020); Palea and Drogo (2020); Maaloul (2018); Zhou et al. (2017); Jung et al. (2018) examining the impact of CE on COD were used as a basis for this study, and size, ROA, leverage, growth, structure, and cash flow were taken as control variables. These variables, also taken as control variables in previous studies, influence COD. The calculation of these control variables is given in Table 1, and information related to these variables was obtained from the companies' annual reports, financial statement footnotes and disclosures, and the DataStream database.

3.4. Research Model and Hypotheses

To detect the influence of CE on COD of companies listed in the BIST-SI, CE [Total CE (in Metric Tons); CEI = Total CE / Total Sales] was taken as the independent variable, while size, ROA, leverage, growth, structure, and cash flow were taken as control variables. COD was taken as the dependent variable, and the research model is shown in Figure 1.

Figure: 1
Research Model: The Impact of CE on COD



$$LnCOD_{(i,t)} = \beta_0 + \beta_1(\text{Ln}TotalCE)_{(i,t)} + \beta_2(CEI)_{(i,t)} + \beta_3(\text{Ln}SIZE)_{(i,t)} + \beta_4(ROA)_{(i,t)} + \beta_5(LEV)_{(i,t)} + \beta_6(GROWTH)_{(i,t)} + \beta_7(STRUCTURE)_{(i,t)} + \beta_8(CASHFLOW)_{(i,t)} + \in_t \quad (1)$$

In this model, i = 1, 2,……..N represents the number of companies (38); t = 1, 2, 3, …T represents the periods (5 years - from 2017 to 2021).

NxT represents the total number of observations in the dataset (38x5 = 190).

The hypotheses developed within the scope of the research model are as follows:

Hypothesis 1: Total CE (Scopes 1, 2, and 3 GHG emissions in metric tons) significantly affect COD.

Hypothesis 2: CEI has a significant effect on COD.

Hypothesis 3: Company size has a significant effect on COD.

Hypothesis 4: ROA has a significant effect on COD.

Hypothesis 5: Leverage has a significant effect on COD.

Hypothesis 6: Growth (Market Value/Book Value) significantly affects COD.

Hypothesis 7: Company structure has a significant effect on COD.

Hypothesis 8: Company cash flow has a significant effect on COD.

3.5. Research Methodology

The objective of the research is to detect the influence of CE on COD, using data from 38 companies in the sample. Data was obtained from the companies' annual reports, financial statement footnotes, sustainability reports, and integrated reports and was encoded in Microsoft Excel 2020 using total CE (sum of Scopes 1-2-3 GHGs in metric tons), CEI (total CE/total sales), size, return on assets (ROA), leverage, growth, structure, cash flow, and COD as variables. The encoded data was analysed using the STATA package software, and the pooled OLS method was used in the panel dataset.

3.6. Descriptive Statistics

Descriptive statistics related to dependent and independent variables used in the analysis are shown in Table 2.

Table: 2
Descriptive Statistics

Variables (n=190)	Mean	Standard Dev.	Minimum	Maximum
Ln COD	12.780	1.649	8.055	16.623
Ln Total CE	12.388	2.425	6.361	16.943
CEI (%)	0.492	2.560	0.000	19.297
SIZE	18.653	2.731	10.293	23.751
ROA (%)	0.044	0.064	-0.273	0.239
LEV (%)	0.699	0.223	0.075	1.837
GROWTH (M/B) (%)	2.115	19.344	-172.710	196.320
STRUCTURE (%)	6.913	40.826	0.001	261.591
CASH FLOW (%)	3.903	23.488	0.000	182.840

The minimum and maximum values, averages and standard deviations of dependent, independent and control variables are shown in Table 2. Accordingly, the sample's minimum and maximum values of the dependent variable, COD, were 8.055 and 16.623, respectively. The minimum and maximum values of the independent variable, total CE, were 6.361 and 16.943, respectively, while the minimum and maximum values of CEI were 0.000 and 19.297, respectively. The fact that the means of the ROA, growth, structure, and cash flow

variables were smaller than their respective standard deviation values suggests significant variability in these series.

3.7. Correlation Analysis

Correlation analysis is a statistical method used to measure the degree of linear relationship between two variables. As a result of the correlation analysis, whether a correlation coefficient finds a linear relationship between the variables and the degree of this relationship. The correlation coefficient, denoted by "r," measures the degree of correlation among variables, which may range between -1 and +1 (Sungur, 2014: 115; Özşahin-Koç, 2017: 110).

Table 3 presents the correlation matrix between independent and control variables and COD.

Table: 3
Correlation Matrix for Independent and Control Variables

	Ln COD	Ln Total CE	CEI (%)	SIZE	ROA (%)	LEV (%)	GROWTH (M/B) (%)	Structure (%)	CASH FLOW (%)
Ln Total CE	0.057	1							
CEI (%)	0.039	0.067	1						
SIZE	0.005	0.070	-0.479**	1					
ROA (%)	-0.373**	-0.062	-0.066	-0.238**	1				
LEV (%)	0.511**	-0.221**	-0.160*	0.125	-0.517**	1			
GROWTH (M/B) (%)	-0.006	0.003	-0.010	-0.105	0.037	0.031	1		
Structure (%)	0.048	0.027	0.977**	-0.475**	-0.062	-0.157*	-0.010	1	
CASH FLOW (%)	0.042	0.023	0.972**	-0.472**	-0.060	-0.155*	-0.009	0.982**	1

Note 1: ** and * indicate significance at p<0.01 and p<0.05, respectively.
Note 2: The correlation Coefficient is weak if it is 50 and lower and strong if it is 50 and over (Nakip, 2003: 322).

When examining Table 3, it can be stated that the size variable has a weak negative correlation with CEI. It has also been determined that ROA's COD and size have a weak negative correlation with a worthless degree of relationship.

Leverage has a relatively strong positive correlation with COD and a weak negative correlation with total CE, CEI, and ROA. The structure has a very strong positive correlation with CEI, a weak negative correlation with size, and a weak negative correlation with leverage. Similarly, cash flow has a very strong positive correlation with CEI, a weak negative correlation with size, and a weak negative correlation with leverage. However, the correlation analysis results do not indicate any significant relationship between total CE or CEI and COD. Moreover, no significant relationship was found between growth and COD.

3.8. Panel Data Analysis

In this study, the Pooled Ordinary Least Squares (POLS) method, a traditional static panel data analysis, is employed to analyse the determinants of COD.

The panel dataset includes both the series' horizontal and time dimensions. The method of combining time series and cross-sectional analysis and testing appropriate models is called panel data analysis. The difference between panel data regression and well-known time series or cross-sectional regressions is that the variables have a dual index (i, t)

(Sayılgan & Süslü, 2011: 83). Also, the data obtained by combining time series and cross-sectional data is called "Longitudinal or Pooled Data". In this context, the Pooled OLS (POLS) method was used for panel data analysis, and the results are presented in Table 4. Possible variable variance and autocorrelation were considered in the COD model, and robust standard errors were reported.

Tablo: 4
Pooled OLS Analysis Results for Panel Data

Independent Variables	Standardised Beta Coefficients	T value	Standard Error
Ln Total CE	0.129***	2.90	0.044
CEI (%)	-0.172*	-1.79	0.096
SIZE	-0.026	-0.69	0.038
ROA (%)	-2.796	-1.40	1.991
LEV (%)	4.526***	5.99	0.755
GROWTH (M/B) (%)	-0.001	-0.45	0.004
STRUCTURE (%)	0.015***	3.53	0.004
CASH FLOW (%)	-0.017	-0.25	0.006
$R^2 = 0.377$			
F= 8.178			
N= 190			
Note 1: ***, **, and * indicate significance at p<0.01; p<0.05; and p<0.10, respectively.			

Dependent Variable: COD (Ln COD)
Independent Variable: Ln Total CE, CEI (%), SIZE, ROA (%), LEV (%), GROWTH (M/B) (%), STRUCTURE (%), CASH FLOW (%)

The panel data analysis results show that the total CE variable significantly impacts COD at p<0.01. In other words, when total CE increases by one unit, COD increases by 0.129. Therefore, the analysis results show that as companies' CE - the total amount of CE (in metric tons) they release into the environment - increases, their COD from credit institutions also increases. The variable used to examine the effect of CE on COD, CEI (GHG Emissions Intensity), also has a significant impact on COD at p<0.10 level. In other words, when CEI decreases by one unit, COD decreases by 0.172. The control variables, leverage, and structure significantly impact COD at a 1% level. The leverage ratio indicates the percentage of a company's assets financed by debt, and a high ratio implies that the company has a higher financial risk. The significance between COD and leverage implies that companies with high debt financing, or in other words, companies that prefer debt financing in their capital structure, face higher COD. However, it was found that the variables of size, ROA, growth, and cash flow do not significantly affect COD. Falk and Miller (1992) stated in their study that the R^2 value should be equal to or higher than 0.10 for the variance to be considered sufficient. In the study conducted by Cohen (1988), it was stated that an R^2 value of 0.26 is significant, 0.13 is moderate, and 0.02 is weak in explaining the variance. In this context, the determination coefficient (R^2) value of the current study model is 0.377, which is considered a sufficient and significant value for explaining the variance.

The acceptance and rejection status of the hypotheses of the study model resulting from the analyses performed is presented in Table 5.

Table: 5
Results of Hypothesis Testing in the Study Model

Hypotheses	Accept/Reject
Hypothesis 1: Total CE (the total amount of Scopes 1, 2, and 3 GHGs in metric tons) significantly affects COD.	Accept
Hypothesis 2: CEI has a significant effect on COD.	Accept
Hypothesis 3: The size of the company has a significant impact on the COD.	Reject
Hypothesis 4: ROA has a significant influence on COD.	Reject
Hypothesis 5: Leverage has a significant influence on COD.	Accept
Hypothesis 6: Growth (Market Value/Book Value) has a significant effect on COD	Reject
Hypothesis 7: Corporate structure has a significant influence on COD	Accept
Hypothesis 8: The company's cash flow has a significant influence on COD	Reject

Table 5 shows that both supporting and non-supporting results were obtained for the study's hypotheses.

4. Conclusion

CE and GHGs, significant issues for our planet today, have become a vital threat to all living creatures, especially humans. Appropriately managing and reducing CE and other GHGs is crucial for the UN's Sustainable Development Goals (SDG) for nature and the life cycle. Therefore, regulatory and supervisory bodies, especially country administrations, have significant roles. Legal regulations, framework agreements, and commercial agreements such as the UNFCCC, the Kyoto Protocol, and the Paris Climate Agreement have been made in this context. It is essential for companies, as significant components of the global commercial system and those that emit the most carbon into the atmosphere, to comply with environmental and social regulations to ensure their sustainability.

In this study, which examines the effect of companies' CE on COD, the annual reports, footnotes, sustainability, and integrated reports of 38 companies traded on the BIST-SI between 2017 and 2021 were analysed. It was concluded that total CE, CE intensity, leverage, and company structure variables significantly impact COD. However, it was found that the size, return on assets (ROA), growth, and cash flow variables do not substantially affect COD.

It was found that total CE, CE intensity, leverage, and company structure variables impact COD, while the size, ROA, growth, and cash flow variables do not. When compared with similar studies in the literature, this study's findings show both similarities and differences.

Jung et al. (2018) concluded that CEI and leverage significantly affected COD. Palea and Drogo (2020) found that CEI and leverage significantly affected COD. Wang et al. (2020) found that total CE, CEI, and structure variables had significant effects on COD, while ROA did not have a considerable effect. Zhou et al. (2017) found that CEI, leverage, and structure variables significantly affected COD, but growth variables did not. Kumar and Firoz (2018) found that total CE and leverage significantly affected COD. Maaloul (2018) saw that total CE, CEI, and leverage significantly affected COD. Caragnano et al. (2020) found that total CE, CEI, and leverage significantly affected COD. Pizzutilo et al. (2020)

found that CEI and leverage significantly affected COD. Kozak (2021) found that CEI and leverage significantly affected COD. Vullings (2021) found that CEI and leverage significantly affected COD. These findings are similar to those obtained in this study.

Jung et al. (2018) detected that size and cash flow significantly affected COD. Wang et al. (2020) found that size and growth had significant effects on COD, while leverage did not have a considerable effect. Zhou et al. (2017) found that size, ROA, and cash flow significantly affected COD. Kumar and Firoz (2018) found that size significantly affected COD. Maaloul (2018) found that size, ROA, and growth significantly affected COD. Caragnano et al. (2020) found that size, ROA, and cash flow significantly affected COD. Pizzutilo et al. (2020) found that size and ROA significantly affected COD. Kozak (2021) found that size and ROA significantly affected COD. Vullings (2021) found that size, ROA, and growth significantly affected COD. These findings contradict those obtained in this study.

Based on the findings obtained in this study, the following recommendations are made to practitioners and researchers regarding CED:

To serve the SDG adopted by the UN, lending institutions are advised to consider non-financial information such as risk reports, CED, and CEI when assessing the credibility of companies and considering environmental performance indicators. On the other hand, companies can include strategic plans to cope with climate change and manage the CEI they are exposed to or may face. Efforts should also be made to raise awareness of CEI.

Regulatory authorities are recommended to develop new technologies that eliminate or minimise CE, support renewable energy industries, and create financial support and incentive packages. Also, developing countries with lower environmental awareness are recommended to pass binding and incentivising CE-related laws. Such mandatory regulations can contribute to reducing CE.

This study examined the relationship and impact between the CE of companies listed on the BIST-SI and their COD. Future studies can investigate the relationship and effect between CED and COD of companies listed on other indexes (BIST 30, BIST 100, etc.). In the following studies, regarding this research, the impact of CE on COD can be applied to companies traded on different exchanges in several countries, and data can be analysed comparatively. This study examined Total CE (the total amount of Scopes 1, 2, or 3 GHGs in metric tons). Moreover, in future studies, the impact of only Scope 3 indirect GHG emissions on COD can be investigated, or comparative analyses can be conducted by examining the effect of Scopes 1 and 2 direct GHG emissions and Scope 3 indirect GHGs on COD separately. When examining the impact of CE on COD, size, ROA, leverage, growth, structure, and cash flow were included as control variables in the analysis. In the following studies, other control variables such as volatility, company age, Altman Z Score, beta, and Tobin's Q Ratio can be added to the analysis. This study used five-year annual reports of companies, financial statement footnotes and disclosures, sustainability reports,

and integrated reports as information sources for CED. In future studies, time series analyses can be conducted by expanding the years (beyond a five-year dataset) and examining the CED of companies. In Türkiye, the relationship between CE and capital costs can be discussed.

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Appendix

Appendix: 1
BIST Sustainability Index List of Companies Inspected

Rank	Code	Company Title
"1"	"AKBNK"	"AKBANK T.A.Ş."
"2"	"AKCNS"	"AKÇANSA ÇİMENTO SANAYİ VE TİCARET A.Ş."
"3"	"AKENR"	"AKENERJİ ELEKTRİK ÜRETİM A.Ş."
"4"	"AKSA"	"AKSA AKRİLİK KİMYA SANAYİİ A.Ş."
"5"	"AKSEN"	"AKSA ENERJİ ÜRETİM A.Ş."
"6"	"ALBRK"	"ALBARAKA TÜRK KATILIM BANKASI A.Ş."
"7"	"AEFES"	"ANADOLU EFES BİRACILIK VE MALT SANAYİİ A.Ş."
"8"	"ARCLK"	"ARÇELİK A.Ş."
"9"	"ASELS"	"ASELSAN ELEKTRONİK SANAYİ VE TİCARET A.Ş."
"10"	"AYGAZ"	"AYGAZ A.Ş."
"11"	"BRISA"	"BRİSA BRIDGESTONE SABANCI LASTİK SANAYİ VE TİCARET A.Ş."
"12"	"CCOLA"	"COCA-COLA İÇECEK A.Ş."
"13"	"CIMSA"	"ÇİMSA ÇİMENTO SANAYİ VE TİCARET A.Ş."
"14"	"DOAS"	"DOĞUŞ OTOMOTİV SERVİS VE TİCARET A.Ş."
"15"	"ENKAI"	"ENKA İNŞAAT VE SANAYİ A.Ş."
"16"	"EREGL"	"EREĞLİ DEMİR VE ÇELİK FABRİKALARI T.A.Ş."
"17"	"FROTO"	"FORD OTOMOTİV SANAYİ A.Ş."
"18"	"SAHOL"	"HACI ÖMER SABANCI HOLDİNG A.Ş."
"19"	"KERVT"	"KEREVİTAŞ GIDA SANAYİ VE TİCARET A.Ş."
"20"	"KORDS"	"KORDSA TEKNİK TEKSTİL A.Ş."
"21"	"LOGO"	"LOGO YAZILIM SANAYİ VE TİCARET A.Ş."
"22"	"MGROS"	"MİGROS TİCARET A.Ş."
"23"	"OTKAR"	"OTOKAR OTOMOTİV VE SAVUNMA SANAYİ A.Ş."
"24"	"POLHO"	"POLİSAN HOLDİNG A.Ş."
"25"	"SKBNK"	"ŞEKERBANK T.A.Ş."
"26"	"SOKM"	"ŞOK MARKETLER TİCARET A.Ş."
"27"	"TOASO"	"TOFAŞ TÜRK OTOMOBİL FABRİKASI A.Ş."
"28"	"TCELL"	"TURKCELL İLETİŞİM HİZMETLERİ A.Ş."
"29"	"TUPRS"	"TÜPRAŞ-TÜRKİYE PETROL RAFİNERİLERİ A.Ş."
"30"	"GARAN"	"TÜRKİYE GARANTİ BANKASI A.Ş."
"31"	"HALKB"	"TÜRKİYE HALK BANKASI A.Ş."
"32"	"ISCTR"	"TÜRKİYE İŞ BANKASI A.Ş."
"33"	"TSKB"	"TÜRKİYE SINAİ KALKINMA BANKASI A.Ş."
"34"	"SISE"	"TÜRKİYE ŞİŞE VE CAM FABRİKALARI A.Ş."
"35"	"VAKBN"	"TÜRKİYE VAKIFLAR BANKASI T.A.O."
"36"	"ULKER"	"ÜLKER BİSKÜVİ SANAYİ A.Ş."
"37"	"YKBNK"	"YAPI VE KREDİ BANKASI A.Ş."
"38"	"ZOREN"	"ZORLU ENERJİ ELEKTRİK ÜRETİM A.Ş."

Source: Public Disclosure Platform (2022).