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Impact of Board of Directors on Funds Raising: Evidence for Green Bonds

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Abstract

The present paper attempts to reveal influence of characteristic features of the board of directors (BD) on fund raising using green bonds. The research involved a sample of 87 public companies which issued green bonds in 2021. We analyzed influence of such factors as the proportion of women and independent directors on the BD, CEO duality and the number of the BD members by the share of green bonds in the total debt of the company. The share of debt in the assets, the natural logarithm of total assets (company size) and return on equity (ROE) were used as control variables.

The logarithmic specification of the classical linear regression model was chosen as the optimal one. So, heteroscedasticity, autocorrelation and multicollinearity were not detected in the model with the dependent variable logarithm (the share of green bonds in the total debt). The least squares method (LSM) was applied to evaluate this model.

As long as the initial sample of companies which issued green bonds in 2021 comprises both financial and non-financial companies we verified the validity of the obtained results for two types of companies. Assessment of the optimal model for two subsamples of financial and non-financial companies yielded results somewhat different from the ones obtained from analysis of the total sample. Evaluation of the regression for financial and non-financial companies showed a reduction in significance of influence exerted by women's representation and the size of the BD. However, in case of non-financial companies the significance of such factor as presence of the sustainable development committee increases. According to the obtained results the companies with the CSR committee attract relatively larger financing using green bonds.

Keywords: sustainable development, board of directors, generalized method of moments, fixed effects panel model, least squares method, meta-analysis, panel data models, green bonds

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Introduction

Over the recent years, increasingly greater attention has been paid to global problems, thus, responsible business practices, assistance in sustainable development, preservation of the environment and minimization of human impact on it have become a priority for some large companies. However, these activities entail significant capital investments. This is precisely the reason for the creation of green bonds – a financial instrument with a fixed income. They are used to attract funds for the implementation of projects related to environment protection and mitigation of climate change consequences [1].

The green bond market has begun to develop rather recently. In November 2008, the World Bank was the first organization to issue green bonds in order to extend credits for climate change-related projects. According to the analysts of the *Climate Bonds Initiative*, the annual amount of green bonds' issue in 2023 may exceed \$1 tln. [2].

The subject of the influence of the board of directors (BD) on fundraising using green bonds is relevant because it has not been studied in Russian or foreign literature.

The purpose of the present paper is to reveal the BD characteristics that have a significant stimulating or, on the contrary, restraining effect on fundraising using green bonds.

The research object is represented by companies that have issued green bonds and the research subject is the characteristics of the BD of such companies and their influence on fundraising using green bonds.

The information base comprises the data on the size of green bond issuance by public companies in 2021, and the share of females and independent directors on the BD, CEO duality, presence of a CSR committee in the company, the size of the BD, debt to assets ratio, total assets and return on equity. Some of the data was taken from *Bloomberg* and the other part was collected manually from annual company reports for 2021. Calculations were made using the *Gretl* statistical package and *Excel*.

The theoretical foundation comprises the articles dedicated to the study of the influence of BD composition on decision-making in regard to sustainable development, and an analysis of green bonds as the financing source (influence of green bond issuance on capital value). Almost all considered papers are empirical and apply econometric methods to test hypotheses and answer the research question.

Literature Review

The problem of the influence of the characteristic features of BD composition on corporate sustainable development was studied by multiple authors [3–14]. In the considered papers, the authors used a regression analysis of time series in an attempt to reveal the impact of BD composition on the efficiency of corporate sustainable development, including Corporate Social Responsibility (CSR), and environmen-

tal, social and corporate governance (*Environmental, Social and Governance*, or the ESG-rating). One of the considered studies [14] described the influence of BD composition on the amount of investments in environmental protection.

The method most frequently used for the evaluation of influence of BD composition on the efficiency of corporate sustainable development is the **generalized method of moments** (GMM). For example, it was used by V. Naciti [3] in his paper. His research sample contained 362 large companies from 46 countries and 26 industries, which were a part of the *Fortune Global 500 list*¹ at least once between 2013 and 2016. The author concluded that female representation, the share of foreign directors and the absence of CEO duality had a positive impact on sustainable development efficiency, while the share of independent directors had a negative impact.

A similar methodology was applied in the paper by S. Karim [5] to analyze the influence of the share of women occupying the positions of executive and independent directors on the interrelation between the CEO and executive directors' remuneration and CSR practices. A sample of 483 listed Malaysian companies in 2006-2017 was used for the research. As a result, the author concluded that the proportion of female executive directors has a significant influence on the mitigation of the dependence between remuneration size and CSR practices, while the proportion of female independent directors has an insignificant impact on the mitigation of this dependence.

The GMM was also used by C. Francoeur et al. [9]. In this paper, the authors studied the influence of female representation in the BD on various groups of stakeholders. The research was conducted based on a sample of only American companies from *Fortune 500*, whose social performance in 2007-2013 was evaluated by *Sustainalytics*. The authors arrived at the conclusion that female representation in the BD had a positive impact on weaker stakeholder groups (the environment, suppliers, the social one) and had no impact on employees or buyers.

A similar methodology was used by R. Beji et al. [10]. In this paper, the authors tried to reveal the influence of various BD characteristics on CSR in general and on its specific aspects. Such characteristics include BD size, share of foreign and independent directors, CEO duality, directors' sex, age diversity, education level, academic background, the fact of occupying several director's positions by the same person. A sample of all companies from the *SBF120* index (France) from 2003 to 2016 was used for the research. The authors concluded that BD size, share of independent directors, age diversity, education level and the fact of occupying several director's positions by the same person produce a positive impact on the general CSR rating. Female representation has a positive influence only on governance quality and human rights. The share of foreign directors exerts a positive impact on the aspects related to the environment and society.

¹ Rating of companies based on the amount of revenue and published annually in *Fortune*.

Apart from the GMM, some papers we have considered applied the **fixed effects panel model**. The paper by M. Valls Martínez et al. [4] is an example. The authors tried to reveal the influence of gender diversity in the BD on CSR efficiency in the developed and emerging European markets. The sample comprised all European companies included in *MSCI Europe (MSCI)* and *MSCI Emerging Markets Europe (MSCI EM)* in 2010-2019. The authors arrived at the conclusion that female representation had a positive impact on CSR efficiency and that this impact is stronger in the developed markets than in emerging ones.

A similar fixed effects model was also applied in paper by A. Uyar et al. [11], where the authors tried to define the influence of BD composition on CSR efficiency. The research sample comprised all healthcare companies listed in the *Refinitiv Eikon* database in 2011-2018. The authors concluded that the presence of a CSR committee, female representation and a larger share of independent directors on the BD exert a positive influence on the efficiency of CSR practices, while CEO duality and a large BD – have a negative impact.

The paper by G. Birindelli et al. [13] was based on a similar methodology. It tried to detect characteristic features of BD composition that improve the efficiency of sustainable development in banking. The sample comprised data on 108 public European and American banks for 2011-2016. The researchers concluded that female representation on the BD, the presence of a CSR committee, a large BD size have a positive influence on ESG rating, while the share of independent directors – a negative one.

The next group of papers is based on applying the **least squares method (LSM)**. It was used in paper by P. Prudêncio et al. [7], which is dedicated to revealing the influence of gender and age diversity on the BD and management of Brazilian companies. The sample comprised 317 companies listed on the *B3 S.A.* stock exchange in 2016-2017. As a result, the researchers concluded that a high female representation on the BD produced a positive influence on the CSR rating. BD size also has a positive influence on the CSR rating because a larger number of people provides more experience, knowledge and innovative solutions. The average age of BD members has no impact on the CSR rating, while age heterogeneity (age variation coefficient) influences the CSR rating negatively. The presence of women and age heterogeneity in management produce no influence on the CSR rating because management is focused more on achieving financial performance objectives.

LSM without taking into consideration the individual effects was also used in research by X. Jiang and A. Akbar [14], which was dedicated to the influence of female representation in management on investments in environmental protection. It used a sample of 359 Chinese public companies over the period of 2008-2016. Research results showed that women occupying the positions of the CEO and the chairman of the board, as well as the presence of women on the BD had a positive impact on investments in the environment due to the social responsibility characteristic that is unrelated to industry specifics.

A series of papers apply other data analysis methods. For instance, the paper by J. Endrikat et al. [6], which tried to detect the interrelation between BD characteristics and CSR efficiency used **meta-analysis** (random effects model). It was conducted using a sample of 82 empirical studies of the influence of BD characteristics on CSR in 1991-2019. The authors arrived at the conclusion that BD size, female representation, share of independent directors and presence of a CSR committee exert a positive impact on CSR efficiency.

The paper by S. Chen S et al. [8], which studies the influence of the number of directors with experience as directors of non-commercial organizations on CSR efficiency uses **panel data models** (Poisson regression and population-averaged linear regression). The research sample comprised all companies from *S&P 500* in 2009-2016. The results showed that directors with experience in non-commercial organizations produce a positive influence on CSR efficiency only in the three years following their assignment to the BD.

The paper by R. Jin et al. [12] used **propensity score matching** and the **Heckman two-stage model** to analyze the influence of independent female directors on the CSR strategy. The sample consisted of all public Chinese companies operating in real sectors and listed on the Shanghai and Shenzhen stock exchanges in 2008-2015. The authors concluded that independent female directors had a positive impact on the internal, but not the external CSR rating.

The paper by U.S. Bhutta et al. [15] classified the studies of **green bonds** and reviewed the factors related to development of the green bond market and their influence on the fundamental indicators of corporate performance. The authors analyzed 53 papers on this topic published between 2008 and 2020 in *Scopus* and *Web of Science* science citation databases. As a result, the authors concluded that the quality of information disclosure exerts a positive impact on the development of the green bond market. Regulators' support also has a positive influence on development of the green bond market. However, the authors failed to make unambiguous conclusions concerning the influence of green bond issuance on corporate financial performance. For this reason, we considered other papers on this topic.

All the papers we have discovered that discuss characteristics of green bonds as a financing source are empirical ones and indicate that green bond issuance decreases the cost of financing. For instance, in the paper by R. Zhang et al. [16], dedicated to the influence of green bond issuance to finance environmental protection initiatives on the cost of capital, the authors analyze a sample of 1,010 green bonds issued in China as at 31.12.2020 and conclude that green bond issuance reduces the cost of capital in three ways: decrease of information asymmetry, upsurge of corporate share liquidity, mitigation of anticipated risk.

Paper by F. Taghizadeh-Hesary et al. [17] analyzed economic and financial performance of the hydrogen power industry projects in China and defined an appropriate mechanism of green financing for those projects. The au-

thors considered three hydrogen projects in China (hydrogen manufacture, hydrogen liquification and transportation, hydrogen filling stations). The authors conclude that in order to mitigate the risks of financing and cost of capital, the sources of hydrogen project funding in China should be diversified: loans should amount to about 56% in the capital structure, and green financing sources – to approximately 44%.

G. Gianfrate and M. Peri [18] also tried to answer the question regarding the reduction of funding cost when issuing green bonds. They analyzed a sample of 121 green bond issues (in euro) in 2007 - 2017. In order to compare the income from green and conventional bonds, the authors applied propensity score matching. As a result, they arrived at the conclusion that green bonds were more convenient financial instruments as compared to conventional ones because investors expected a relatively low income from them.

Another research study that confirms a decrease in the cost of financing in case of green bond use is the paper by Z. Li et al. [19], which describes the factors defining the interest expense of green bonds. The authors considered 114 green bonds issued by Chinese public companies from 2016 to 2018. They concluded that the issuer's type (financial or non-financial organization) has no impact on interest expenses, while green certification, a higher credit rating and CSR rating lead to lower spreads and, consequently, to interest expenses.

The hypothesis that green bond issuance helps to reduce the financing cost is also confirmed in the paper by B. Lin and T. Su [20], where the authors tried to find out which factors stimulate the issue of green and conventional bonds. In order to answer the posed question, they considered a sample of 9,255² bond issues in China in 2016-2021. The authors reached the conclusion that companies preferred to issue green bonds in order to decrease the cost of financing and conventional bonds – to attract more funds.

On the basis of the literature review, we may set forth the following hypotheses.

Table 1. Variables used in the research

Variables	Measurement unit	Description	Data source
Dependent variable			
<i>GB_share_in_debt</i>	%	Share of green bonds in the total debt	Author's calculation on the basis of <i>Bloomberg</i> data
Independent variables			
<i>ind_on_board</i>	%	Share of independent directors on the BD	<i>Bloomberg</i>
<i>women_on_board</i>	%	Women representation on the BD	<i>Bloomberg</i>

² The authors [20] eliminated from the sample non-public companies and bonds which had no potential for issue as green bonds (according to the intended purpose of raised funds), the exact number of green bonds issues analyzed in the paper is not stated.

1. Other conditions being equal, a larger female representation on the BD has a positive influence on fundraising using green bonds.
2. Other conditions being equal, the presence of a CSR committee has a positive influence on fundraising using green bonds.
3. Other conditions being equal, the absence of CEO duality has a positive influence on fundraising using green bonds.
4. Other conditions being equal, a larger BD size has a positive influence on fundraising using green bonds.
5. Other conditions being equal, a share of independent directors on the BD has no significant influence on fundraising using green bonds.

Data Used in the Research

In order to verify the suggested hypotheses, we used data from the *Bloomberg* database on green bond issues in 2021. Apart from the volume of green bond issue, such company indicators as the share of independent directors and female representation on the BD, the total debt to total assets ratio and total assets were taken in absolute terms. The main and only criterion for adding a green bond issue to the sample was the availability of data for all the above indicators. Thus, the initial sample comprised 124 green bond issues of 2021.

Subsequently, the author collected such indicators as the presence of a CSR committee (or ESG committee/sustainable development committee), CEO duality, BD size, and return on equity (ROE) manually from the 2021 annual reports of the companies included in the initial sample. In view of geopolitical events, the final sample consisted of 87 companies that issued green bonds in 2021. It should be noted that the data used in this paper is of spatial nature (cross-sectional data).

The final list and a brief description of the variables used in the present research are presented in Table 1.

Variables	Measurement unit	Description	Data source
<i>CEO_duality</i>	Binary variable (1 – no, 0 – yes)	CEO duality	Corporate annual reports
<i>CSR_committee</i>	Binary variable (1 – yes, 0 – no)	Presence of the CSR committee	Corporate annual reports
<i>board_size</i>	Person	BD size	Corporate annual reports
Control variables			
<i>debt_to_assets</i>	%	Share of debt in total assets	<i>Bloomberg</i>
<i>ln_total_assets</i>	–	Company size	Author's calculation on the basis of <i>Bloomberg</i> data
<i>ROE</i>	%	Return on equity	Corporate annual reports

Source: Compiled by the author.

It should be noted that the share of green bonds in total debt of each company was selected as the dependent variable instead of the absolute green bond issue volume because a relative indicator demonstrates the scope of fundraising using green bonds in a more unbiased way.

Independent and control variables were defined based on the literature review.

Choosing the Optimal Model

Since the data collected for the research is of spatial nature, the author considered it reasonable to apply LSM to analyze it. The following model was constructed on the basis of the collected data:

$$GB_share_in_debt_i = \alpha + \beta_1 \cdot ind_on_board_i + \beta_2 \cdot women_on_board_i + \beta_3 \cdot CEO_duality_i + \beta_4 \cdot CSR_committee_i + \beta_5 \cdot board_size_i +$$

$$+ \beta_6 \cdot debt_to_assets_i + \beta_7 \cdot ln_total_assets_i + \beta_8 \cdot ROE_i + \varepsilon_i$$

where *GB_share_in_debt_i* – the share of the green bond issue in 2021 in total debt expressed in %; α – the constant/permanent component of the model; *ind_on_board_i* – the share of independent directors on the BD expressed in %; *women_on_board_i* – female representation on the BD expressed in %; *CEO_duality_i* – the fact of the CEO also occupying the position of the chairman of the board, a binary variable (1 – no, 0 – yes); *CSR_committee_i* – the presence of a sustainable development committee in the company, a binary variable (1 – yes, 0 – no); *board_size_i* – number of BD members, persons; *debt_to_assets_i* – the share of debt in total assets, expressed in %; *ln_total_assets_i* – company size, the natural logarithm of corporate total assets; *ROE_i* – return on equity, expressed in %; ε_i – model errors.

The results of evaluation of the initial model using LSM are presented in Table 2.

Table 2. Results of evaluation of the initial model using LSM

Variable	Coefficient	Standard error	t-statistics	P-value
const	0.79796	0.10526	7.581	6.07e–11***
<i>ind_on_board</i>	0.01755	0.05714	0.307	0.7595
<i>women_on_board</i>	–0.30746	0.10669	–2.882	0.0051***
<i>CEO_duality</i>	0.03514	0.03402	1.033	0.3047
<i>CSR_committee</i>	0.02385	0.02484	0.961	0.3398
<i>board_size</i>	–0.00496	0.00339	–1.460	0.1482
<i>debt_to_assets</i>	–0.21722	0.08274	–2.625	0.0104**
<i>ln_total_assets</i>	–0.04623	0.00530	–8.714	3.87e–13***

Variable	Coefficient	Standard error	t-statistics	P-value
ROE	0.04681	0.10919	0.429	0.6693
Mean value of dependent variables	0.091189			
Sum of squared errors	0.924892			
R-square	0.535260			
F (8,78)	11.22946			
Logarithmic likelihood	74.21574			
Schwarz criterion	-108.2383			
Standard deviation of dependent variables	0.152122			
Standard error of the model	0.108893			
Adjusted R-square	0.487594			
P-value (F)	1.97e-10			
Akaike criterion	-130.4315			
Hannan-Quinn criterion	-121.4950			

** Coefficients significant at the 10 and 5% significance levels.

*** Coefficients significant at all reasonable significance levels.

Source: Author's calculation performed in *Gretl*.

The *P*-value of *F*-statistics obtained as a result of evaluation of the initial model has the value of $1.97e-10$, which is below any reasonable significance level. This factor demonstrated that the initial model is generally significant. However, it should be noted that the *R*-square of the model is rather low and amounts to 0.54 when rounded, i.e., this model explains only 54% of the sample.

As a result of the evaluation of the initial model, the constant (at any reasonable significance level), female representation on the BD (at any reasonable significance level), the share of debt in corporate total assets (at the 10 and 5% significance levels) and the natural logarithm of corporate total assets (at any reasonable significance level) turned out to be significant variables. All significant variables, except the constant, produce a negative influence on fundraising using green bonds.

Such variables as the share of independent directors on the BD, CEO duality, presence of the sustainable development committee, BD size and return on equity have no significant impact on fundraising using green bonds.

However, in order to understand whether we may trust the obtained LSM estimators, we have to make sure that the analyzed model meets a range of conditions. LSM estimators for the linear regression model are unbiased, efficient and consistent (i.e., they are close to their true values) only when the prerequisites of the **classical linear regression model** (CLRM) or the Gauss-Markov conditions are fulfilled.

These prerequisites are as follows:

1) mathematical expectation of random error in any observation equals zero:

$$M(\varepsilon_i) = 0;$$

2) constant variability of random error for all observations:

$$D(\varepsilon_i) = M(\varepsilon_i^2) = \sigma^2;$$

3) no systematic relation between the random error values for any two observations:

$$\text{cov}(\varepsilon_i, \varepsilon_j) = 0;$$

4) independence of the random error from explanatory variables:

$$\text{cov}(x_i, \varepsilon_j) = 0;$$

5) normal distribution of random errors:

$$\varepsilon_i \approx N(0, \sigma^2);$$

6) no correlation between dependent variables (no multicollinearity).

The first prerequisite in this case is fulfilled automatically because an intercept term is added to the model. Subsequently, the tests for the fulfillment of the first prerequisite have not been performed in the present paper. The second prerequisite implies that random error variance does not depend on the number of the observation and is called homoscedasticity (dependence of the random error variance

on the number of the observation is called heteroscedasticity). If there is heteroscedasticity in the model, LSM estimators will be inefficient. The third prerequisite is usually not fulfilled when the data is represented by time series. If the precondition of random errors' uncorrelatedness is violated, there is autocorrelation in the model and LSM estimators also become inefficient. Since the data used in the research is of spatial nature, the tests for autocorrelation have not been conducted. In case of failure to fulfill the fourth prerequisite, LSM estimators become biased and inconsistent. The fifth prerequisite, which concerns the normal distribution of random errors, should be fulfilled to obtain an opportunity to test the hypotheses. The sixth prerequisite is also to be fulfilled in the considered case because the research study analyzes a multiple linear regression inasmuch as several characteristics of the BD composition influence fundraising using green bonds.

Thus, the above-described CLRM prerequisites were verified in the following order: verification of normality of distribution of the model's random errors; verification of absence of heteroscedasticity in the model; verification of absence of multicollinearity in the model.

The hypothesis regarding the normality of distribution of random errors in the initial model was verified by the Jarque-Bera test. The test results showed that the P -value amounted to 0.0000 bringing us to the conclusion that the hypothesis regarding normal distribution of the model residuals is rejected at any reasonable significance level.

The hypothesis of the absence of heteroscedasticity was verified using the White test. The test results showed that the P -value amounts to 0.0499. Consequently, the hypothesis about the absence of heteroscedasticity in the model is accepted only at the 1% significance level.

In order to detect multicollinearity in the initial model, we constructed a correlation matrix for all variables. The maximum correlation coefficient (-0.65) was revealed between the share of green bonds in financing sources ($GB_share_in_debt$) and the natural logarithm of total assets (\ln_total_assets). The correlation between other variables is significantly lower (the correlation coefficients do not exceed 0.29). Subsequently, we may conclude that there is no multicollinearity in the initial model.

Thus, only one prerequisite regarding the normal distribution of random errors is not fulfilled in the initial model of dependence of the share of green bonds in total debt on BD characteristics. In order to solve this problem, the author decided to consider and analyze the model with a log-transformed dependent variable. All other variables underwent no changes.

The new model is as follows:

$$\begin{aligned} \ln_GB_share_in_debt_i = & \alpha + \beta_1 \cdot ind_on_board_i + \\ & + \beta_2 \cdot women_on_board_i + \beta_3 \cdot CEO_duality_i + \\ & + \beta_4 \cdot CSR_committee_i + \beta_5 \cdot board_size_i + \\ & + \beta_6 \cdot debt_to_assets_i + \beta_7 \cdot \ln_total_assets_i + \\ & + \beta_8 \cdot ROE_i + \varepsilon_i, \end{aligned}$$

where $\ln_GB_share_in_debt_i$ – the natural logarithm of the share of green bond issue in 2021 in total debt; α – the constant/permanent component of the model; $ind_on_board_i$ – the share of independent directors on the BD expressed in %; $women_on_board_i$ – female representation on the BD expressed in %; $CEO_duality_i$ – the fact of the CEO also occupying the position of the chairman of the board, a binary variable (1 – no, 0 – yes); $CSR_committee_i$ – presence of a sustainable development committee in the company, a binary variable (1 – yes, 0 – no); $board_size_i$ – number of BD members, persons; $debt_to_assets_i$ – the share of debt in total assets, expressed in %; $\ln_total_assets_i$ – company size, the natural logarithm of corporate total assets; ROE_i – return on equity, expressed in %; ε_i – model errors.

The random errors of this model were also verified for normality by the Jarque-Bera test. The P -value amounted to 0.0578, hence, the hypothesis regarding the normal distribution of random errors is accepted at the 1% and 5% significance levels.

The log-transformed model was also verified for heteroscedasticity using the White test. The P -value amounted to 0.6955. This brings us to the conclusion that the hypothesis about the absence of heteroscedasticity is accepted at any reasonable significance level.

Finally, the log-transformed model was verified for multicollinearity. A correlation matrix was built for all model variables. The highest correlation coefficient (0.93) was detected between the natural logarithm of the share of green bonds in total debt ($\ln_GB_share_in_debt$) and the natural logarithm of total assets (\ln_total_assets). In other cases, the correlation coefficients do not exceed 0.38, bringing us to the conclusion that there is no multicollinearity in the model.

Thus, the log-transformed specification of the model of dependence of green bonds in corporate total debt on characteristics of the BD composition is the optimal one.

Results of Use of the Optimal Model

Above we defined the optimal model for analyzing the influence of characteristic features of BD composition on fundraising using green bonds.

The specification of the optimal model is as follows:

$$\begin{aligned} \ln_GB_share_in_debt_i = & \alpha + \beta_1 \cdot ind_on_board_i + \\ & + \beta_2 \cdot women_on_board_i + \beta_3 \cdot CEO_duality_i + \\ & + \beta_4 \cdot CSR_committee_i + \beta_5 \cdot board_size_i + \\ & + \beta_6 \cdot debt_to_assets_i + \beta_7 \cdot \ln_total_assets_i + \\ & + \beta_8 \cdot ROE_i + \varepsilon_i. \end{aligned}$$

The results of evaluation of this model are presented in Table 3.

Table 3. Results of evaluation of the optimal model using the LSM

Variable	Coefficient	Standard error	t-statistics	P-value
const	6.52295	0.50343	12.960	3.87e-21***
<i>ind_on_board</i>	0.19890	0.27327	0.728	0.4689
<i>women_on_board</i>	1.54601	0.51026	3.030	0.0033***
<i>CEO_duality</i>	-0.05708	0.16269	-0.351	0.7267
<i>CSR_committee</i>	0.08436	0.11878	0.710	0.4797
<i>board_size</i>	0.05213	0.01623	3.211	0.0019***
<i>debt_to_assets</i>	-3.42632	0.39572	-8.658	4.97e-13***
<i>ln_total_assets</i>	-0.92302	0.02537	-36.380	1.09e-50***
ROE	1.55170	0.52225	2.971	0.0039***
Mean value of dependent variables	-4.030957			
Sum of squared errors	21.15697			
R-square	0.956278			
F (8,78)	213.2503			
Logarithmic likelihood	-61.94132			
Schwarz criterion	164.0758			
Standard deviation of dependent variables	2.372072			
Standard error of the model	0.52081			
Adjusted R-square	0.951794			
P-value (F)	9.78e-50			
Akaike criterion	141.8826			
Hannan-Quinn criterion	150.8192			

*** Coefficients significant at all reasonable significance levels.

Source: Author's calculations performed in *Gretl*.

It may be deduced from Table 3 that the optimal model is statistically significant because the *P*-value of *F*-statistics amounts to 9.78e-50, which is below any reasonable significance level. The *R*-square of the log-transformed model (0.95) exceeds the *R*-square of the initial model (0.54), which is indicative of a higher quality of the regression. That is to say, the optimal model explains 95% of the sample.

Moreover, evaluation of the optimal model showed that along with the constant, female representation on the BD, debt to assets ratio and natural logarithm of corporate total assets, such variables as BD size and return on equity also turned out to be significant. It should be emphasized that all the above-mentioned variables are significant at any reasonable significance level.

According to the obtained results, a larger female representation on the BD, a bigger BD size and a higher return on equity lead to raising relatively larger funds using green bonds. The rest of the variables (the share of independent directors, CEO duality, presence of a sustainable development committee) produce no significant impact on fundraising using green bonds. The obtained results also indicate that companies with greater borrowed funds and large companies attract financing using green bonds in relatively smaller amounts.

The final results of verification of the hypotheses set forth at the beginning of the paper are stated in Table 4.

Table 4. Results of verification of hypotheses

Hypothesis	Confirmation
1. Other conditions being equal, a larger female representation on the BD has a positive influence on fundraising using green bonds.	Yes
2. Other conditions being equal, the presence of a CSR committee has a positive influence on fundraising using green bonds	No
3. Other conditions being equal, the absence of CEO duality has a positive influence on fundraising using green bonds	No
4. Other conditions being equal, a larger BD size has a positive influence on fundraising using green bonds	Yes
5. Other conditions being equal, the share of independent directors on the BD has no significant influence on fundraising using green bonds	Yes

Source: Compiled by the author.

The research results show that three of the five suggested hypotheses are correct.

Verification of Results

Inasmuch as the studied sample of green bond issue in 2021 comprises companies from various sectors, including financial and non-financial ones, it is reasonable to verify the results described in the previous section for reliability based on the type of company (financial/non-financial).

In order to verify the results using the LSM, we assessed the optimal log-transformed model for financial and non-financial companies separately. Financial companies comprise the firms from *financial* or *bank* sectors, and all other companies are considered to be non-financial. As a result of division, we obtained two similar samples of 43 financial companies and 44 non-financial ones. The results of evaluation of the optimal model for financial companies are presented in Table 5.

Table 5. Results of evaluation of the optimal model for financial companies using the LSM

Variable	Coefficient	Standard error	t-statistics	P-value
const	7.13506	0.68311	10.440	3.78e-12***
<i>ind_on_board</i>	0.09854	0.39443	0.250	0.8042
<i>women_on_board</i>	1.47310	0.76895	1.916	0.0638*
<i>CEO_duality</i>	0.14527	0.29652	0.490	0.6273
<i>CSR_committee</i>	-0.12301	0.18597	-0.662	0.5128
<i>board_size</i>	0.03997	0.02762	1.447	0.157
<i>debt_to_assets</i>	-3.87595	0.60657	-6.390	2.70e-07***
<i>ln_total_assets</i>	-0.93951	0.04225	-22.240	7.76e-22***
ROE	0.51900	1.11606	0.465	0.6449
Mean value of dependent variables	-4.428914			
Sum of squared errors	8.909481			
R-square	0.952379			
F (8,78)	84.99687			
Logarithmic likelihood	-27.17155			

Variable	Coefficient	Standard error	<i>t</i> -statistics	<i>P</i> -value
Schwarz criterion	88.1939			
Standard deviation of dependent variables	2.110589			
Standard error of the model	0.511902			
Adjusted <i>R</i> -square	0.941174			
<i>P</i> -value (<i>F</i>)	3.31e-20			
Akaike criterion	72.3431			
Hannan-Quinn criterion	78.1884			

* Coefficients significant at the 10% significance level.

** Coefficients significant at the 10 and 5% significance levels

*** Coefficients significant at all reasonable significance levels.

Source: Author's calculation performed in *Gretl*.

Based on the data in Table 5, we may conclude that the regression for financial companies is statistically significant (the *P*-value of *F*-statistics amounts to 3.31e-20, which is below any reasonable significance level). The *R*-square of the model is rather high and means that the model explains 95% of the sample.

However, the results of regression evaluation for financial companies in regard to BD characteristics that influence

fundraising using green bonds differ from the results of evaluation of the general regression: the significance of influence of female representation on the BD decreases, and the significance of influence of the BD size is also lost.

The results of evaluation of the optimal model for non-financial companies are stated in Table 6.

Table 6. Results of evaluation of the optimal model for non-financial companies using the LSM

Variable	Coefficient	Standard error	<i>t</i> -statistics	<i>P</i> -value
const	6.06140	0.86644	6.996	3.87e-08***
<i>ind_on_board</i>	0.24377	0.43356	0.563	0.5773
<i>women_on_board</i>	1.76057	0.79147	2.224	0.0327**
<i>CEO_duality</i>	-0.17845	0.20676	-0.863	0.3940
<i>CSR_committee</i>	0.30789	0.16718	1.842	0.0740*
<i>board_size</i>	0.05037	0.02260	2.229	0.0323**
<i>debt_to_assets</i>	-3.06651	0.59100	-5.189	9.07e-06***
<i>ln_total_assets</i>	-0.91234	0.04035	-22.610	1.81e-22***
<i>ROE</i>	1.97713	0.67600	2.925	0.0060***
Mean value of dependent variables	-3.642044			
Sum of squared errors	9.909411			
<i>R</i> -square	0.965027			
<i>F</i> (8.78)	120.7199			
Logarithmic likelihood	-29.63779			
Schwarz criterion	93.33329			

Variable	Coefficient	Standard error	t-statistics	P-value
Standard deviation of dependent variables	2.566968			
Standard error of the model	0.532096			
Adjusted R-square	0.957033			
P-value (F)	3.65e-23			
Akaike criterion	77.27558			
Hannan-Quinn criterion	83.2306			

* Coefficients significant at the 10% significance level.

** Coefficients significant at the 10 and 5% significance levels

*** Coefficients significant at all reasonable significance levels.

Source: Author's calculation performed in *Gretl*.

Based on the data in Table 6, we may conclude that the regression for non-financial companies is also statistically significant (the *P*-value of *F*-statistics amounts to 3.65e-23, which is below any reasonable significance level). The *R*-square of the model is rather high and indicates that the model explains 96% of the sample.

The results of regression evaluation for financial companies in regard to BD characteristics that influence fundraising using green bonds differ from the results of evaluation of the general regression: the significance of influence of female representation on the BD and the significance of influence of the BD size are diminished. However, at the same time a factor as the presence of the sustainable development committee acquires significance. According to the obtained results, companies with a CSR committee attract relatively larger funds using green bonds.

Thus, the results obtained from the analysis of the general sample and subsamples for financial and non-financial companies differ. Subsequently, it is necessary to conduct further studies on the influence of BD characteristics on fundraising using green bonds in various industries.

Conclusion

The present paper is dedicated to revealing the influence of characteristic features of BD composition on fundraising using green bonds. In the research we used the sample of 87 public companies that issued green bonds in 2021. In this paper we analyzed the influence of such factors as female representation and share of independent directors on the BD, CEO duality and the BD size on the share of green bonds in corporate total debt. The following variables were used as control variables: the share of debt in assets, the natural logarithm of total assets (company size) and return on equity (ROE).

A log-transformed specification of the classical linear regression model was selected as the optimal model. As long as heteroscedasticity, autocorrelation and multicollinearity

were not detected in the model with the dependent variable logarithm (share of green bonds in total debt) we used the LSM to evaluate it. The following results were obtained based on the evaluation of the optimal model:

- a larger female representation on the BD, a bigger BD size and a higher return on equity result in raising relatively larger financing using green bonds;
- such factors as the share of independent directors, CEO duality, presence of a sustainable development committee have no significant impact on fundraising using green bonds;
- companies with larger borrowed funds and larger companies attract financing using green bonds in relatively smaller amounts.

Since the initial sample of the companies that issued green bonds in 2021 comprises both financial and non-financial companies, we verified the reliability of the obtained results for these two types of companies. Evaluation of the optimal model for two subsamples of financial and non-financial companies yielded the results that are somewhat different from the ones obtained from the analysis of the general sample. An assessment of the regression for financial and non-financial companies showed a decrease in the significance of influence of female representation on the BD and BD size. However, in case of non-financial companies, the factor of the presence of a sustainable development committee becomes significant. The obtained results suggest that companies with a CSR committee attract relatively greater amounts of financing using green bonds.

Thus, it is necessary to conduct further research on the influence of characteristics of BD composition on fundraising using green bonds. For example, this dependence may be considered for various industries instead of just global groups, such as financial and non-financial companies. Also, this dependence may be considered from the point of view of the region where companies operate (for example, developed/emerging countries).

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