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Board Diversity and Environmental Performance with a Focus on Moderating Effect of Board Independence

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Abstract

The present study was to investigate the relationship between board diversity and environmental performance with much emphasis on the moderating effect of board independence in this context. Four research hypotheses were tested and analyzed using the data from 108 companies listed on the Tehran Stock Exchange (TSE), Tehran, Iran, during 2018- 2023 (including 648 company-year observations) through Logistic Regression (LR). Environmental performance refers to the extent to which a company pays attention to the impacts of its operations on environmental pollution and was assessed through three operational components in the form of an environmental performance checklist. The study results established a significant positive relationship between age and tenure diversity and environmental performance in the companies listed on the TSE, Tehran, Iran. However, no significant relationship was found between gender diversity and environmental performance. As well, board independence and tenure diversity had moderating effects in the relationship between age diversity and environmental performance, but board independence could not moderate the relationship between gender diversity and environmental performance. The findings of this study make valuable implications for understanding how board diversity can serve as a driver for the environmental performance issue.

Keywords:
Board Diversity, Board Independence, Environmental Performance

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1. Introduction

Given the growing trend in the world's population and the expansion of business-related activities and then serious impacts on the environment, millions of people are globally concerned about the preservation of the environment. In view of that, some major issues like air quality and pollution, carcinogens, global warming, and overconsumption of non-renewable energy sources are every day's top stories. Many companies are further seeking for environmental efficiency, viz., increasing the production of goods and services and reducing their harmful impacts on the environment (Badavar et al., 2016). As the lack of macro policies and inattention to planning strategies are among the problems facing the environment, it is necessary to include them in the laws and regulations of most countries across the world. Currently, there are many policymaking laws and regulations to protect the environment in Iran, highlighting environmental issues in this region. Such laws and regulations are typically divided into financial and non-financial ones, wherein supervising the financial ones requires the establishment of appropriate accounting systems to provide better reports on financial and environmental performance (Abbasi and Mohammadi, 2012). In general, the evidence shows that boards and managers in large-scale companies lay much focus on environmental pollution reduction programs and the ways to improve them. There are thus significant implications for experts and policymakers regarding the effectiveness of internal management mechanisms in companies addressing the risks caused by climate change and the possible relationship between administrative reforms and policies related to environmental pollution. Shareholders are also putting much pressure on managers to assess the risks and opportunities related to climate change and report the financial consequences of their decision-making in companies. This now requires financial and human resources, technologies, as well as long-term strategic commitments by shareholders, boards, and chief executive officers (CEOs). Companies accordingly can create values when their management system contains different features, particularly in connection with the integration of economic, environmental, and social dimensions. Of note, beneficiaries with conflicting and heterogeneous interests raise demands for compensation for damages caused by environmental pollution (Sajjadi and Banobi Ghadim 2015). Independent boards evaluate management performance more efficiently, which in turn reduces environmental pollution. Since independent managers are not involved in daily operations and have indirect financial interests in companies, or they are dependent on CEOs, they are less influenced. On the other hand, opportunistic behaviors make them provide more realistic feedback about operations in companies and successfully supervise boards (Movahedi, 2015). In this context, female board members are more committed and stricter and less self-oriented in their decision-making, which makes them more successful (Wang and Coffey, 1998; Solberg, 2006). Moreover, female managers might have their own sociological perceptions and concepts to expand the decision-making scope in boards.

The results of previous studies and research on the concept of environmental performance show that most of the research has been conducted in developed economies such as the United States and Europe, where the level of environmental awareness is high. However, few studies have been conducted in developing countries. One reason for this could be the lack of appropriate and specific indicators and criteria for assessing environmental performance in developing countries. Of course, in some of these countries there are indicators for assessing environmental performance, but their reliability and accuracy are low. In this study, we selected three operational components in the form of an environmental performance checklist. Also, in this study, we examined the relationship between board diversity, which includes age diversity, tenure diversity, and gender diversity, on environmental performance in companies listed on the Tehran Stock Exchange, which was

conducted for the first time in Iran.

Against this background; first, the research problem was stated, and then the importance of the research, its objectives, hypotheses, variables, statistical population, samples, and setting were delineated. As the final point, the conceptual model definitions were given.

2. Theoretical foundations, literature review, and hypothesis development

2.1 Theoretical foundations

Thus far, numerous benefits have been raised for board performance evaluation, including the possibility of increased accountability and higher standards set for activities (Kazemi Ulom et al., 2019). Now, it is widely accepted that companies need to lay focus on environmental performance. They are also under much pressure from the society to be more accountable for environmental issues and climate change (Acar et al., 2021). Although the environment is a vital issue, board diversity has not attracted much attention in the related literature and limited studies have been so far fulfilled on age, tenure, gender, and some moderating factors. Over recent years, board diversity has been significantly addressed, especially in developing countries with emerging economies due to their specific requirements. Of note, companies with high diversity in their board members are able to bring wide-ranging perspectives to help obtain good environmental scores and meet interests in different groups (Al-Jaifi etal., 2023). Moreover, today's environmental changes push companies to respond to a series of undefined factors and become aware of all changes and problems (viz., internal and external complications) that occur in their surrounding environment. This puts companies in positions to have different but structured looks at environmental opportunities in challenging settings and then adopt approaches to deal with ups and downs. To survive and progress in these complexities, they need precise planning and appropriate strategies and tools to implement their goals, which demand the identification of the effective factors in this line. Likewise, investigating the complex environment of companies is always very important for owners and investors to boost management (Jian et al., 2019).

Board independence is one of the key mechanisms, which is of importance due to its influence on company results, including environmental performance. Empirically, it has been established that independent managers pay much more attention to environmental performance (Beji et al., 2021) and social awareness (Ibrahim and Angelidis, 1994) and are more concerned about compliance with laws and regulations related to environmental performance (Kassinis and Vafeas, 2002). Although board independence is an internal monitoring mechanism to minimize conflict of interest between managers and shareholders, the negative impact of CEO tenure on social and environmental disclosure in companies is more obvious in those with more independent managers (Khan et al., 2021). Board diversity can also lead to innovative decision-making in terms of protection of natural resources, waste management, and pollution reduction. As well, cultural differences and various experiences of board members can promote many attitudes and approaches to environmental issues. Balance and independence in boards accordingly play vital roles in environmental protection and recovery. A proper balance can thus result in making decisions in which the needs of the environment, such as saving forests, mitigating environmental pollution, and preventing biodiversity loss are taken into account (Katoria, 2020). Besides, board age is one of the most observable features of diversity, as it indicates the effect of different generations, values, motivations, cultures, habits, and experiences on the decision-making approaches adopted by managers. According to the Resource Dependence Theory (RDT), heterogeneous structures of boards are preferred over the homogeneous ones, so difference in board age can be useful for future planning and business success (Handajani et al., 2014). Different age groups in boards thus

contribute to better understanding of environmental, social, and corporate governance (ESG) issues and improvement in corporate governance attitudes. There are still few studies on the relationship between board age and environmental performance disclosure, and there is limited empirical evidence to prove that board age diversity produces higher performance in companies (Ali et al., 2014). Since the increase in mean age represents a homogeneous board structure, there is a negative relationship between board age and environmental performance, consistent with the RDT (Menicucci and Paolucci, 2022a). Gender diversity here refers to the active presence of women and men on boards, committees, and other positions. In recent years, studies have further highlighted the leading role of women in company management (Daily et al., 2000; Terjesen, 2009). In this sense, Imani et al. (2017) found that gender diversity in board members could improve their communication and the practice of diverse and operative viewpoints among them and audit committees. According to Joy (2008), the participation of women on boards of companies could boost the efficacy of communication with investors. As stated by Adams and Ferreira (2009), Abbott et al. (2012), Gul et al. (2008), and Kreder and Evert (2016), board members and accountability of top managers could augment board dynamism and independence, activities and efforts by auditors, disclosure, and management behavior, and consequently reduce capital costs.

From this perspective, the main question raised was: "How does board diversity, including board independence, act as a stimulus for environmental performance in companies?"

In other words, "How does board independence moderate the relationship between board diversity and environmental performance in companies?"

2.2 Literature review

Yavuz et al. (2025) examined whether ESG performance has an impact on financial performance? (Evidence from Turkey). The study employed panel regression analysis on data from 21 companies listed in the Borsa Istanbul-100 index over the period 2011–2020 to investigate the relationship between ESG sub-dimensions and firm performance. The findings indicate that adopting the environmental and governance sub-dimensions positively affects ROE and Tobin's Q. However, the adoption of the governance sub-dimension negatively impacts Tobin's Q while positively influencing ROE. No statistically significant results were found regarding the impact of ESG sub-dimensions on firms' ROA ratios. Zhu et al. (2024) in their study titled "Addressing ESG Investing in China: Does Board Composition and Financial Decisions Matter?" found that there is a positive and significant relationship between board independence and gender diversity in board structure and ESG performance. In line with the study objectives, Al-Jaifi et al. (2023), reflecting on the effects of board diversity on environmental performance and the moderating effect of board independence with evidence from the Asia-Pacific region, recruited 14878 company-year observations from 11 Asia-Pacific countries, and showed a positive relationship between environmental performance and age and gender diversity, but board diversity had a negative relationship in this respect. This could be attributed to the Alliance Hypothesis (AH), in which longer board tenure could lead to favorable management biases and ultimately reduce environmental activities. They also confirmed that board independence moderated the relationship between tenure and gender diversity and environmental performance. Paolone et al. (2023) also investigated longer board and audit committee tenure and the way they could influence environmental performance. The data were collected from the Refinitiv Eikon database, as a sample of the European Union-listed companies belonging to old countries from 2018 to 2020. They concluded that longer board and audit committee tenure boosted environmental performance, suggesting that companies could consider tenure as a proxy for board oversight quality, and tenure was negatively correlated with environmental performance. Once boards had low turnover,

companies might achieve lower environmental performance. Menicucci and Paolucci (2023) further examined a sample of 247 Italian Cooperative Credit Banks (CCBs) for 2017-2021 and developed an econometric model using unbalanced panel data with company-year fixed effects and controls. Their findings revealed that board size and independence as well as the presence of corporate sustainability committee (CSC) had a positive effect on ESG performance of such banks, while there was no significant relationship between board age and such performance. In this context, Cambrea et al. (2023) studied a sample of Italian companies listed on the Telematics Market during 2019- 2023 and showed that a critical mass of at least three female managers was necessary to improve ESG performance, and female CEOs were the vital components of board mechanisms in terms of aligning stakeholders' needs, because they could increase such performance. As well, Porter and Sherwood (2022) explored the relationship between SEC laws and regulations with much focus on board independence and financial reporting quality, and examined different board independence paths.

Their sample included 1248 company-year observations, whose board composition was compared between 2001 and 2008. The results designated that companies chose between multiple paths to comply with independence requirements, and the way companies operationalized ESG requirements affected financial reporting quality. Moreover, Menicucci and Paolucci (2022b) shed light on the impact of board diversity and ESG performance of 105 Italian banks from 2017 - 2021, and then evaluated boards in terms of their characteristics, viz., size, age, gender, independence, corporate social responsibility (CSR), and CSC. Their main empirical results demonstrated that board size and independence and CSC presence positively shaped ESG performance in the given banks, while no significant relationship was found between board age and ESG performance. In addition, the relationship between board gender and performance was positive, but the effect of female managers on ESG performance when there were women was nonlinear. In Kalbuana et al. (2022), the Agency Theory (AT) was proposed as a solution to explain the roles of profitability, board size, and female board members under two categories, i.e., women on the board and those in commissions, as well as political connections with financial problems. The panel data were obtained from the companies listed on the LQ-45 for the Indonesia Stock Exchange in 2017-2021, and then analyzed by a quantitative approach through the Ordinary Least Squares (OLS) regression, the Fixed and Random Effects, and strong relationships, simultaneously. The analysis results revealed higher accuracy compared to the Partial Correlation Test. As elucidated, profitability ratio had a negative effect on financial distress and board size positively influenced it, but female board members had no impact on financial distress. However, women on the board had a positive effect on financial distress and political communication was not so.

2.3 Hypothesis development

2.3.1 Age diversity

Upon raising the research questions, the hypotheses were developed to express a specific relationship between two or more variables. In the literature related to board age diversity, there were different views about the importance of this variable and participation in environmental activities. In this regard, Said et al. (2012) concluded that companies with older managers practiced more environmental performance disclosure, because they could apply their experiences into decision-making. In contrast, Ibrahim and Hanefah (2016) found a positive relationship between young board members and environmental activities, that is, they stated that young managers were more concerned about environmental issues. Given this, the first research hypothesis (1) was developed as follows:

H1: There is a significant relationship between board age diversity and environmental performance.

2.3.2 Tenure diversity

In the literature on board tenure diversity, the significance of this variable and contribution to environmental activities had been thus far clarified. For example, Mahmoodi and Ghaffari (2016) established a significant positive relationship between management tenure and financial performance in companies in terms of the environment, work environment, society, and country and the capital market in relation to corporate responsibility. As well, Al-Jaifi et al. (2023) explained that environmental performance was positively and negatively correlated with board diversity, which was ascribed to the AH, in which long-terms tenure in boards could induce managerial biases and finally reduce environmental activities. Accordingly, the second research hypothesis (2) was developed as follows:

H2: There is a significant relationship between board tenure diversity and environmental performance.

2.3.3 Gender diversity

As shown in the literature on board gender, there were various perspectives toward this variable and involvement in environmental activities. In this line, Parsa and Kanani (2022) argued that board gender diversity had an effect on CSR. On the other hand, Saghafi and Hajiha (2022) investigated the relationship between board gender diversity and CSR, and then and showed that the presence of female board members and financial expertise of board members did not significantly affect CSR. Considering this, the third research hypothesis (3) was developed as follows:

H3: There is a significant relationship between board gender diversity and environmental performance.

2.3.4 Moderating effect of board independence

Board independence is a monitoring mechanism in the company that is essential for the company because it protects the interests of shareholders and checks the balance of management. According to the AT, independent directors have more control and monitoring over the management of the company. In addition, the stakeholder theory states that independent directors need social demands. For this reason, companies engage in environmental activities. Considering the above, it is argued that independent directors have a high awareness of social and environmental issues and are likely to present themselves as responsible for solving such issues. The fact that independent directors are more likely to be sensitive to stakeholder pressure on environmental issues is justified because engaging in sustainability projects or activities, including environmental ones, for the benefit of stakeholders increases their reputation and ultimately increases the likelihood of their board nomination (Post et al., 2014).

Nadeem (2020) supported that firms with higher board independence undertake supplemental environmental projects more frequently. Beji et al. (2021) provided evidence that independent directors care more about CSR performance. Furthermore, De Villiers et al. (2011) found that the environmental strengths of firms are positively and significantly related to board independence. Considering the above, the fourth hypothesis of the research is designed as follows:

H4a: There is a significant relationship between board age diversity and environmental performance moderated by board independence.

H4b: There is a significant relationship between board tenure diversity and environmental performance moderated by board independence.

H4c: There is a significant relationship between board gender diversity and environmental performance moderated by board independence.

3. Methods

In total, a sample of 108 companies listed on the TSE, Tehran, Iran, were selected from various industries (viz., manufacturing and industrial). They consisted of subcategories, and selected due to the significant impact of their activities on environmental performance. Since financial and investment companies could operate under different laws and regulations, and they had their own financial reporting characteristics, they were excluded. In this study, environmental performance refers to the extent to which a company pays attention to the impacts of its operations on environmental pollution and was assessed through three operational components in the form of an environmental performance checklist. As a result, the data from 2018 to 2023 were collected and analyzed using content analysis. The reason for choosing this time frame was that a longer time horizon, for example, over five years, could mitigate concerns about the unreliability of the accounting data (Cornett et al., 2010). The study data were collected manually from the CODAL database, and then the financial information of the companies was extracted from the software package developed by the TSE. Table 1 presents the selection method for sampling companies and industries. In total, 648 company-year observations were obtained from financial reports and analyzed during hypothesis testing. To control the outliers, all variables were winsorized at the 1% and 99% levels.

Table 1. Sample selection process

Description	Frequency	Percentage
Total number of companies listed on TSE at the end of 2023	603	100
Criteria		
Companies not active in TSE during 2018-2023	217	35.98
Companies listed on TSE before 2018	161	26.70
Companies other than holding companies, investment companies, financial intermediaries, banks, or leasing companies	61	10.11
Companies whose financial year did not end on March 29 or changed financial year during study	56	9.28
Companies whose data were not available during study	-	-
Sample size	108	17.91

3.1 Models

Given that the dependent variable (namely, environmental performance) had two modes of 0 and1, a multiple Logistic Regression (LR) model was used to test the research hypotheses. Although the coefficients of the independent variables could be estimated like that in multivariate regression models in LR, the method of estimation was completely different. The OLS regression was further practiced in the multivariate regression model, in which the sum of the squared difference between the actual and predicted values of the dependent variable was minimized. In LR, another method called the Maximum Likelihood Estimation (MLE) was employed due to the non-linear nature of logit transformation.

Model (1) which is for testing the first, second, and third hypotheses of the research:

$$ENVit = \beta 0 + \beta 1AGEit + \beta 2TENUREit + \beta 3GENDERit + \beta 4SIZEit + \beta 5ROAit + \beta 6LEVit + \beta 7BODSIZEit + \varepsilon it \quad (1)$$

Model (2) which is for testing the fourth hypothesis a, b, c:

$$ENVit = \beta 0 + \beta 1AGEit + \beta 2TENUREit + \beta 3GENDERit + \beta 4BODINDit + \beta 5AGE * BODINDit + \beta 6TENURE * BODINDit + \beta 7GENDER * BODINDit + \beta 8SIZEit + \beta 9ROAit + \beta 10LEVit + \beta 11BODSIZEit + \varepsilon it \quad (2)$$

In both models, the dependent variable was ENV. Board diversity was further measured with reference to three components of AGE, TENURE, and GENDER. As well, AGEit refers to the age diversity, TENUREit is the tenure diversity, GENDERit shows the gender diversity, ROAit stands for the return on assets, SIZEit indicates the actual reporting of total assets, LEVit represents the ratio of book value of debt to book value of total assets, BODSIZEit denotes the board size as the total number of board members, β0 characterizes the constant coefficient, βi is the regression coefficient, and ε suggests the error term of the model. In further tests, the Fixed Effects Method and the modified Test of Endogeneity in regression methods (the Homogeneous Two-Stage Regression Method) were utilized.

3.2 Variables

3.2.1 Dependent variable: environmental performance

According Table 2, It indicates the extent to which the company pays attention to the impact of its operations on environmental pollution. This item has the following operational components. (Zandi and Faghani, 2018).

Table 2. Environmental Performance Checklist

	Indicators	
Paying attention to environmental protection in production/distribution processes	Product health and safety standards	Environmental costs such as pollution control

The following relationship is used to measure it:

$Environment_{it} = \frac{\sum_{n=1}^{n} x_i}{n_i}$, $0 \leq Social_i \leq 1$

n_i= Number of items disclosed by the company

x_i= Dummy variables are assigned the value 1 if the item is disclosed and zero otherwise

3.2.2 Independent variable: board diversity

The key point in the efficient composition of boards was to ensure that their members had enough skills, experiences, and knowledge to analyze the problems in their companies and develop frameworks to find solutions in this line. Accordingly, the best ideas and decisions in board meetings with effective compositions could raise questions in order to explain and interpret the issues facing boards and demand information to help in analyzing the challenges and phenomena. Three key elements needed to be taken into account to create an optimal board composition and select members. Considering these elements and giving specific weight to each one according to the expected roles and expectations in boards could thus significantly contribute to overall improvement and increase collective success. Board diversity could be accordingly measured via three components of age diversity (AGE) or the mean age of managers, tenure diversity (TENURE), as the number of years of service by board members, and gender diversity (GENDER), referring to the percentage of women on boards. (Al-Jaifi et al., 2023)

3.2.3 Moderating variable

In this study, board independence (BDIND) was introduced as the moderating variable, equal to the ratio of non-commissioned managers to the total number of members. (Nakano and Nguyen, 2012).

3.2.4 Control variable

Some control variables in the related literature on environmental performance in companies were further considered. First, return on assets (ROA), calculated as the ratio of net income to mean total assets, was controlled (Imhof and Seavey, 2014). The next was company size (SIZE), computed as the natural logarithm of total assets (De Jonghe et al., 2015). As well, leverage (LEV) was another control variable, calculated as the ratio of total debt to total assets (Benlemlih et al., 2018). Furthermore, the fourth control variable was board size (BDSIZE), equal to the total number of board members.

4. Findings

4.1 Descriptive statistics

The sample examined during 2018-2023 included 108 companies listed on the TSE, Tehran, Iran. Given the combination of data, there were 648 company-year observations. The indices of central tendency were mean and median, and the measures of dispersion were standard deviation (SD) as well as maximum and minimum (Table 3).

Table 3. Descriptive statistics for study variables

Variables	Mean	Median	SD	Minimum	Maximum
Environmental performance	0.722	0.100	0.150	0.000	1.000
Age diversity	48.000	42.000	0.1092	36.000	65.000
Tenure diversity	3.448	2.652	5.216	1.000	8.000
Gender diversity	10.715	8.000	1.036	0.000	20.000
Board independence	2.541	2.316	1.036	1.061	5.6131
ROA	10.352	9.022	11.044	-40.132	45.478
Company size	8.4312	7.5229	0.2009	2.1205	13.109
LEV	0.6731	0.593	0.1821	0.451	0. 921
Board size	5.000	5.000	0.091	3.000	7.000

Mean, as the main index of central tendency, specified the balance point and the center of dispersion. As presented in Table 3, the mean value of environmental performance was equal to 0.10, suggesting that 10% of the companies had components related to environmental performance. The median was also the point that divided the sample into two equal parts. In other words, 50% of the observations were before and 50% of them were after it. If the median was close to the mean, it denoted that the data distribution was close to the normal state. One of the leading measures of dispersion was thus SD. Accordingly, the data dispersion was optimal.

4.2 Inferential statistics

The inferential statistics used in this study was multivariate regression in order to discover the relationships between the independent and dependent variables by controlling the effect of other variables. In addition, regression tests were employed to ensure the reliability of the results.

4.2.1 Model selection

As the data recruited in this study was a combination of cross-sectional and time-series ones, the type of data (viz., composite or panel) needed to be determined using diagnostic tests before fitting the models. For this purpose, F-Limer Test (Chow Test) was operated. The F-Limer Test and

Hausman Test results are given in Table 4.

Table 4. F-Limer test and Hausman test results

Models	Tests	Degree of freedom	Statistic	Probability	Results
Model 1	F-Limer Test	6.113	0.381	0.849	Pooled
Model 2	F-Limer Test	6.113	0.279	0.918	Pooled

As shown in Table 4, the F-Limer Test statistical probability in all four models was greater than 0.05; therefore, the pooled data method was used to estimate them.

4.2.2 Normal distribution of error components

To check the normality of the error components, the Jarque-Bera Test was applied, whose results are presented in Table 5. Accordingly, the significance level in the Jarque-Bera Test was higher than the level of error intended (5%) in all four models in this study. Therefore, the null hypothesis, viz., the normality of the error components, was not rejected, so the error components of the models had a normal distribution.

Table 5. Error component normality test results

Models	Jarque-Bera Test statistic	Statistical probability (Sig.)	Results
Model 1	0.8491	0.2819	Normal
Model 2	1.019	0.1649	Normal

4.2.3 Heterogeneous variance of error components

In the OLS regression, the error components needed to have constant and equal variances, but a fixed one if there was a heterogeneous variance of the error components. Accordingly, the presence of heterogeneous variance was tested, and the Breusch-Pagan Test was used to check the hypothesis (Table 6). The statistical probability for all four models was higher than the 5% error level, so the null hypothesis, i.e., the existence of equal variance of the error components was not rejected. Therefore, there was no heterogeneous variance of the error components.

Table 6. Breusch-Pagan test results

Models		Degree of freedom	Statistic	Statistical probability (Sig.)
Model 1	F-statistic	6.114	0.471	0.719
	Observation× R-squared	6.000	2.291	0.721
Model 2	F-statistic	6.114	1.918	0.116
	Observation× R-squared	6.000	8.884	0.116

4.2.4 Testing H_1, H_2, & H_3

Table 7 shows the summary of fitting the LR model obtained from testing H1, H2, and H3 as well as its estimation. Accordingly, the LR statistical probability was less than the 5% error level, pointing to the model significance at the 95% confidence interval with high reliability. The Durbin-Watson statistic was also equal to 2.109, implying the absence of autocorrelation between the error components of the model. The variance inflation factor (VIF) statistic then suggested no collinearity between the independent variables. Moreover, the coefficient of determination of the model was 0.591, denoting that about 59% of the variances in the environmental performance were explained by the explanatory variables of the model.

Testing the coefficients of the model for H1, the Z statistical probability of board age diversity was 0.0001, which was below the 5% error level. Considering the Z statistic, equal to 4.911 and outside the critical range (-1.96 to 1.96), H1 was confirmed with the 99% probability. Besides, beta coefficient for board age diversity was 0.214, which indicated the significant positive effect of this variable on environmental performance. Regarding the coefficients of the model for H2, the Z statistical probability of board tenure diversity was equal to 0.000, which was less than the 5% error level. Considering the Z statistic, equal to 9.918 and outside the critical range (-1.96 to 1.96), H2 was correspondingly confirmed with the 99% probability. Beta coefficient for board tenure diversity was 0.455, implying the significant positive impact of this variable on environmental performance. With regard to the coefficients of the model for H3, the Z statistical probability of board gender diversity was 0.8048, which was higher than the 5% error level. Given the Z statistic, equal to 0.381 and within the critical range (-1.96 to 1.96), H3 was the confirmed with the 99% probability.

Table 7. Results of fitting Model 1: Assumptions one, two, and three

Variables	Coefficient	Z statistic	Statistical probability (Sig.)	VIF
Constant coefficient	4.168	21.510	0.000	-
Age diversity	0.214	4.911	0.000	1.669
Tenure diversity	0.455	9.918	0.000	1.569
Gender diversity	0.065	0.381	0.804	1.415
ROA	0.719	7.088	0.000	1.561
Company size	1.249	10.221	0.000	1.665
LEV	-0.718	-9.988	0.000	1.612
Board size	0.615	4.328	0.000	1.481
LR statistic	209.2291	Nagelkerke's coefficient of determination	0.591	
LR probability statistic	0.0000	Durbin-Watson's statistic	2.109	

4.2.5 Testing H_4

The results of testing H4 (Table 8) showed that the LR statistical probability was equal to 0.0000, revealing the appropriateness and significance of the model. The Durbin-Watson's statistic value was also 1.877, implying the absence of autocorrelation between the error components of the model. As well, the VIF statistic denoted the absence of collinearity between the independent variables. The coefficient of determination of the model was also 0.471, showing that about 47% of the variances in environmental performance were explained by the explanatory variables of the model.

Regarding the coefficients of the model for H4-1, the Z statistical probability of board age diversity×board independence interaction was 0.000, which was less than the 5% error level. According to the Z statistic, equal to 9.699 and outside the critical range (-1.96 to 1.96), H4-1 was confirmed with the 99% probability. Thus, the moderating effect of board independence on the relationship between board age diversity and environmental performance was established. For the coefficients of the model for H4-2, the Z statistical probability of board tenure diversity×board independence interaction was 0.000, which was below the 5% error level. Given the Z statistic, equal to 5.611 and outside the critical range (-1.96 to 1.96), H4-2 was confirmed with the 99% probability. In view of that, the moderating effect of board independence on the relationship between board tenure diversity and environmental performance was validated. With respect to the coefficients of the model for H4-3, the Z statistical probability of board gender diversity×board independence interaction was 0.4562, which was more than the 5% error level. According to the Z

statistic, equal to 0.049 and within the critical range (-1.96 to 1.96), H4-3 was rejected with the 99% probability. Therefore, the moderating effect of board independence on the relationship between board age diversity and environmental performance was not settled. In other words, board independence failed to moderate the relationship between board gender diversity and environmental performance.

Table 8. Results of fitting Model 2: Assumptions four a, b, c

Variables	Coefficient	Z statistic	Statistical probability (Sig.)	VIF
Constant coefficient	3.265	16.152	0.000	-
Age diversity	0.381	2.646	0.019	1.811
Tenure diversity	0.695	10.619	0.000	1.612
Gender diversity	0.718	0.419	0.719	1.481
Board independence	-0.611	-8.940	0.000	1.815
Board age diversity×board independence	0.719	9.699	0.000	1.261
Board tenure diversity×board independence	0.309	5.611	0.000	1.145
Board gender diversity×board independence	0.104	0.049	0.456	1.118
ROA	0.411	7.884	0.000	1.214
Company size	0.074	3.774	0.006	1.156
LEV	-0.611	10.452	0.000	1.254
Board size	0.310	5.991	0.000	1.883
LR statistic	109.991	Nagelkerke's coefficient of determination	0.471	
LR statistical probability	0.0000	Durbin-Watson's statistic	1.877	

5. Conclusion

Boards are required to consider diversity because of its impact on environmental performance. The search for social legitimacy and the need to meet expectations and demands among stakeholders has so far made companies more aware of the environmental consequences of their activities. Much concern about environmental issues has accordingly led organizations toward implementing preventive strategies in response to public awareness. In this context, environmental policies may be encouraged by corporate governance mechanisms, especially by boards. The present study was thus an attempt to extend previous research by analyzing the role of other less-explored board characteristics, such as cultural diversity, experience, and board tenure, pushing boards to get more prepared to advise and monitor the management in the current competitive environment and lay focus on environmental issues. In addition to boosting corporate governance, companies with better governance would accordingly become more environmentally responsible as shown in available evidence (Chan et al., 2014; Fiandrino et al., 2019; Harjoto et al., 2015).

Of note, environmental performance has been documented as a critical aspect receiving much more attention in companies. Although regulators ask companies move toward board diversity, communities demand them be more environmentally responsible. However, there is still variation in environmental performance among companies. This study aimed to enrich the literature on board diversity and environmental performance by addressing the ways board age, tenure, and gender diversity could influence environmental performance across countries. In this sense, the study results showed that board age diversity had a positive effect on environmental performance, suggesting that companies with older board members were more involved in environmental activities. As well, a positive relationship was observed between board tenure diversity and environmental performance, implying that companies with long-term board tenure might be less

risk-averse to undertake environmental activities. In terms of board gender diversity, female managers were more inclined toward environmental activities.

The study has implications for investors to consider board diversity when making their trading decisions. Traders are further required to know that more diversity in boards indicates commitment to CSR and inclusion, which can be attractive to social responsibility investors. In this sense, they may invest more in companies prioritizing diversity and inclusion and demonstrate good environmental performance, thereby influencing the patterns adopted by traders in their investment choices. In addition, regulators are suggested to formulate policies and operational initiatives to improve environmental performance in companies. The study results are accordingly robust enough for alternative methods of estimation. Hence, examining other board characteristics in future research is recommended. For the Adjusted Analysis, the study results also offer valuable theoretical and practical implications. From a theoretical perspective, this study enriched the literature by providing empirical evidence on the moderating effect of board independence on the relationship between board diversity and environmental performance in companies. Significantly, the results demonstrated that board independence moderated the effect of gender and board diversity on environmental performance. Companies are thus expected to recruit independent female board members, which is critical to an increase in environmental performance. Some valuable concepts were additionally developed for shareholders. Finally, LR was utilized to analyze the hypotheses (Table 9).

Table 9. Study results summarized

Hypotheses	Description	Results
H_1	There is a significant relationship between board age diversity and environmental performance.	Confirmed
H_2	There is a significant relationship between board tenure diversity and environmental performance.	Confirmed
H_3	There is a significant relationship between board gender diversity and environmental performance.	Rejected
$H_{4.a}$	Board independence has a moderating effect on the relationship between board age diversity and environmental performance.	Confirmed
$H_{4.b}$	Board independence has a moderating effect on the relationship between board tenure diversity and environmental performance.	Confirmed
$H_{4.c}$	Board independence has a moderating effect on the relationship between board gender diversity and environmental performance.	Rejected

The first hypothesis claimed that age diversity has a positive and significant effect on environmental performance in companies listed on the Tehran Stock Exchange. This meant that board age diversity had a significant positive effect on environmental performance in the companies listed on the TSE, Tehran, Iran. These results were in line with the reports in Malekian et al. (2019), Vaziri (2021), Ahmadi et al. (2023), Menicucci and Paolucci (2022b), and Al-Jaifi et al. (2023). In the literature related to board age diversity, there were different views about the importance of this variable and participation in environmental activities. For example, Said et al. (2012) concluded that companies with older managers had more environmental disclosure, because they could make the best use of their experiences in decision-making. In contrast, Ibrahim and Hanefah (2016) found a positive relationship between young managers on the board and environmental activities, so they were more concerned with environmental issues.

The second hypothesis claimed that board tenure diversity had a significant positive effect on environmental performance in the companies listed on the TSE, Tehran, Iran. Beta coefficient for board tenure diversity, indicating the significant positive impact of board tenure diversity on

environmental performance. This signified that board tenure diversity had a significant positive effect on environmental performance in the companies listed on the TSE, Tehran, Iran. The results were accordingly in agreement with the reports in Mahmoodi and Ghafari (2016) and Paolone et al. (2023). As stated in Gallego-Álvarez and Rodriguez-Dominguez (2023), these characteristics had a positive effect on a wider range of environmental activities. Thus, companies whose boards were more diverse in terms of gender and cultural background could take more actions. Moreover, boards whose members had more experiences in the industry were more inclined to carry out such environmental activities. Similarly, the effect on environmental views was also positive when members had served with long-term positions in boards. These characteristics could help promote an approach toward sustainability and environmental concerns. The advantages of a broader knowledge base and board diversity could thus lead to a pro-environmental perspective in companies.

The third hypothesis claimed that board gender diversity could have a significant positive effect on environmental performance in the companies listed on the TSE, Tehran, Iran. However, the results of testing the third hypothesis of the research showed that the third hypothesis of the research was not confirmed. This means that no significant relationship was found between gender diversity and environmental performance in companies listed on the Tehran Stock Exchange. supporting the results in Salehi and Eskandarli (2019), Malekian et al. (2019), Parsa and Kanani (2022), Saghafi and Hajiha (2022), Jari Al-Saedi et al. (2022), Menicucci and Paolucci (2022a), and Al-Jaifi et al. (2023). Usually, women who take on management positions have characteristics that are different from the general population of women. Therefore, a situation arises where gender may not have a different impact on the value of the company. Therefore, it is acceptable that gender diversity does not affect the environmental performance of the company.

The first sub-hypothesis of the fourth hypothesis claimed that there is a moderating effect of board independence on the relationship between board age diversity and environmental performance. According to the t statistic, This hypothesis was confirmed with the 99% probability. This implied the moderating effect of board independence on the relationship between board age diversity and environmental performance. The results were also in agreement with those in Mohammadi and Momeni (2021) and Menicucci and Paolucci (2022a).

In the second sub-proposition of the fourth hypothesis board independence could have a moderating effect on the relationship between board tenure diversity and environmental performance. On the subject of the model coefficients, the t statistical probability of board tenure diversity×board independence interaction was confirmed with the 99% probability, denoting the moderating effect of board independence on the relationship between board tenure diversity and environmental performance. The results were thus along with the reports in Mahmoodi and Ghaffari (2016).

In the third sub-hypothesis of the fourth hypothesis, it was claimed that board independence could have a moderating effect on the relationship between board gender diversity and environmental performance. However, the results of testing this research hypothesis showed that the research hypothesis was not confirmed. Based on this, the moderating effect of board independence on the relationship between board age diversity and environmental performance was not confirmed. In other words, board independence failed to moderate the relationship between gender diversity and environmental performance, which was in line with Menicucci and Paolucci (2022b).

As stated in Al-Jaifi et al. (2023), environmental performance was positively related to board age and gender diversity and negatively correlated with board diversity. These results were attributed to the AH, in which long-term tenure in boards caused a managerial-friendly bias that ultimately reduced environmental activities. It was also established that board independence moderated the

relationship between board tenure and gender diversity and environmental performance. In this regard, Liao et al. (2019) found a significant positive relationship between board gender diversity, measured as the percentage of female managers on boards and the willingness to disclose greenhouse gas information. In addition, boards with independent managers or environmental committees tended to be more environmentally transparent. However, such an impact was negligible if committees were not large enough, independent, or active. These results were consistent with the Stakeholder Theory and showed that diverse and independent boards and board-level environmental committees might help balance the financial and non-financial objectives in companies with limited resources and then minimize or adjust conflicting expectations among stakeholders.

Considering the results of testing the research hypotheses, legislators are suggested to take the necessary measures to introduce a mandatory quota for women on boards in order to promote their presence in higher organizational positions in companies. Shareholders are further advised to consider board gender diversity when choosing companies for investments, because companies with gender diversity pay much more attention to environmental pollution reduction programs. It is also recommended to develop laws and regulations in the TSE, Tehran, Iran, to measure and specify environmental responsibilities of companies during their activity as much as possible. Besides, companies should strive to attract independent female board members, as a characteristic critical to increasing environmental performance. Other practical implications for accountants, top managers, and financial managers are to develop capabilities with regard to perceived environmental uncertainty to handle environmental management accounting tools and thus improve organizational environmental performance. Shareholders are additionally suggested to consider board independence before choosing companies for investments, because those with board independence have more environmental pollution reduction programs.

It is recommended that company managers: implement environmental performance indicators as a management method in their organization to improve operational processes in this direction and, consequently, gain long-term economic benefits and accelerate innovation.

Given some inclusion criteria for the companies (e.g., the financial year at the end of March and no changes in the financial year, etc.), 108 companies were selected as the samples, so the generalization of the results to other companies should be done with caution. Based on the theoretical foundations, there were many variables that could shape the dependent variable, but not fully considered in the model and analyzed, which was one of the other study limitations.

The findings of this study provide valuable implications to the traders as a more diverse board may signal a company's commitment to social responsibility, diversity, and inclusion, which can appeal to socially responsible investors. These investors may be more likely to invest in companies that prioritize diversity and inclusion and demonstrate good environmental performance, thereby influencing the paradigm of traders in their investing choices. From a theoretical perspective, this study enriches the literature by providing empirical evidence about the moderation effect of board independence on the associations between board diversity and environmental performance. Notably, the results suggest that the board independence level moderates the effect of age and tenure board diversity on environmental performance. This, in other words, expresses the weak role of women on corporate boards. The findings of this study also provide valuable implications for firms' shareholders as their voting decisions to elect the board of directors need to consider the diversity of the board due to its impact on environmental performance. This study is not circumscribed by any definitive limitations that might impede future research efforts, although the dataset used in this study warrants further consideration. While the current dataset encompasses all publicly listed firms that have an available environmental performance score on TSE.

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